THE JOURNAL OF ENGINEERING EDUCATION

VOLUME 36 NUMBER 8

Contents for April, 1946

A PROPOSED REVISION OF THE CONSTITUTION OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. *Huber O. Croft* 469

CONSTITUTION OF THE SOCIETY 474

PROPOSED AMENDMENTS 475

ORGANIZATION CHART 494

IF I WERE AN ENGINEER. *Richard R. Price* 496

REPORT OF THE FIRST ANNUAL INDUSTRIAL-AGRICULTURAL WEEK AT KANSAS STATE COLLEGE. *A. L. Pugsley* 502

AN EXPERIMENT IN COURSE ADMINISTRATION. *Paul H. Black* 512

A NATIONAL SPOKESMAN FOR ENGINEERS. *A. R. Stickney* 515

HYDROLOGY IN THE CIVIL ENGINEERING CURRICULUM. *H. W. Wood, Jr.* 519

TEACHING AND PRACTICING ELECTRICAL DESIGN. *N. M. Oboukhoff* 522

COLLEGE NOTES 534

NOMINATION BLANK 535

HORIZONTAL OPTIONS THROUGH MAJOR ENGINEERING CURRICULA—ONE SOLUTION TO THE 4-YEAR QUANDARY *L. E. Grinter* 536

PHYSICS COLUMN 542

Published monthly (except during July and August) at Prince and Lemon Sts., Lancaster, Pa., by the Society for the Promotion of Engineering Education under the Supervision of the Publication Committee: P. L. Bishop, Chairman, University of Pittsburgh, Robert E. Doherty, and H. S. Rogers. Entered as second class matter, October 17, 1912, at the Post Office at Lancaster, Pa., under the Act of August 12, 1912. Subscription Price, $3.00 per year; Single Copies, 50 cents.

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

OFFICERS 1945–46

President

H. S. ROGERS, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

First Vice President

N. W. DOUGHERTY, University of Tennessee, Knoxville, Tenn.

Second Vice President

H. M. CROTHERS, South Dakota State College, Brookings, S. D.

Secretary

F. L. BISHOP, University of Pittsburgh, Pittsburgh 13, Pa.

Treasurer

J. S. THOMPSON, McGraw-Hill Book Co., New York City

Assistant Secretary

NELL MCKENRY, University of Pittsburgh, Pittsburgh 13, Pa.

Headquarters

University of Pittsburgh, Pittsburgh 13, Pa.

54th Annual Meeting

Jefferson Hotel, St. Louis, Mo.
June 20–23, 1946

Host

Washington University

COUNCIL

I. Elective Members

Terms Expire in 1945

H. L. Dodge
J. C. Elgin
L. J. Fletcher
C. E. Lawall
*R. L. Spencer
C. E. Tucker
Jos. Weil

Terms Expire in 1946

E. L. Eriksen
W. O. Hotchkiss
Thorndike Saville
R. H. Spahr
G. L. Sullivan
F. L. Wilkinson
W. R. Woolrich

Terms Expire in 1947

H. O. Croft
R. A. Deller
*F. W. Garran
A. F. Greaves-Walker
E. A. Loew
F. C. Vilbrandt
W. C. White

II. Past Presidents—Members Ex-Officio

C. Frank Allen
D. C. Jackson
F. E. Turneaure
Anson Marston
Henry S. Jacoby
Arthur M. Greene
A. A. Potter
G. B. Pegram
O. M. Leland
R. L. Sackett
D. S. Kimball
H. S. Boardman
H. S. Evans
R. A. Seaton
W. E. Wickenden
C. C. Williams
D. S. Anderson
H. P. Hammond
S. B. Earle
K. T. Compton
O. J. Ferguson
D. B. Prentice
A. H. White
H. T. Heald
R. E. Doherty

* Deceased.

A Proposed Revision of the Constitution of the Society for the Promotion of Engineering Education

By HUBER O. CROFT
University of Iowa

Introduction

A few years before the war several members of S.P.E.E. directly connected with Engineering Experiment Stations were discussing the formation of a new organization to deal with the problems of Engineering Research. These problems were accentuated by the pressures of the war, with the result that the Engineering College Research Association was organized in 1942 to bring together a compact and active group of men interested in the direction of research. The history of this organization has been given by its President, Dean W. R. Woolrich, in the January, 1946 issue of THE JOURNAL OF ENGINEERING EDUCATION. Likewise, due to the pressures of the war, the Division of Administrative Officers of Engineering Colleges of S.P.E.E. found it impossible to take quick and direct action on many critical problems without referring the question to the Council of S.P.E.E., a time-consuming task. In order to alleviate this situation, serious discussions were held by the Administrative Division at the 1942 New York Meeting as to whether or not a new and independent group completely divorced from S.P.E.E. should be formed.

The organization of two new groups related to Engineering Education seemed deplorable to say the least and since all of the members of the new groups were already members of S.P.E.E., many members of S.P.E.E., who were not members of the offshoot organizations, believed sincerely that the time had come to revise the constitution of S.P.E.E. in such fashion as to permit more autonomy to the Research and Administrative groups. The desired result would be a consolidation of the Engineering Education groups rather than a fission which might result in a chain reaction of a multiplicity of independent groups, each of which would attempt to speak for Engineering Colleges.

A brief history of the events leading up to the proposal for constitutional changes has been given by President H. S. Rogers in the September, 1945, number of ENGINEERING EDUCATION. A discussion of the problems facing E.C.R.A. has been given by Dean W. R. Woolrich, as noted previously, and the problems of the Division of Administrative Officers have been presented by Dean A. A. Potter, the Chairman of that Division, in the December, 1945, issue of the JOURNAL and

by Dean S. C. Hollister in the November, 1945, issue of the JOURNAL.

These three articles should be carefully reviewed to understand the difficulties that face S.P.E.E. under the present constitution, if the Society is to really represent all phases of Engineering Education and at the same time permit quick action when conditions demand such action.

The Cincinnati meeting of Council in June, 1944 instructed the incoming President, H. S. Rogers, to appoint a committee "To review the Constitution and By-Laws of the Society for the purpose of adapting the organization of the Society to the needs of the present time and submit such recommendations as the committee sees fit to the Council (preferably at the October 1944 meeting in Chicago)."

In accordance with his instructions, President Rogers appointed the following Committee on Revision of the Constitution and By-Laws: G. F. Bateman, H. O. Croft, R. E. Doherty, L. J. Fletcher, S. C. Hollister, Frank Kerekes, A. B. Domonoske, A. A. Potter, R. A. Seaton, A. R. Stevenson, C. E. Tucker, B. R. Van Leer, F. C. Vilbrandt, W. E. Wickenden, W. R. Woolrich and C. R. Young.

As a result of the work of this committee, a proposed organization chart was presented to Council at the October 1944 meeting, which approved the proposed plan "in principle." After carefully considering all proposals, criticisms, and frank differences of opinion, both verbal and written (over a hundred letters with suggestions have been received), the Committee presents the proposed revisions of the Constitution and By-Laws side by side with the present Constitution and By-Laws for serious study by all members of the Society. The New Constitution will be presented to the Council, and to the members at the regular meeting in June 20-23, 1946, in St. Louis.

A DISCUSSION OF SUGGESTED CHANGES IN THE CONSTITUTION AND BY-LAWS

A brief discussion of the more important changes which are suggested follows:

(The suggested organization chart, together with pertinent details is given on page 474 and should be used in conjunction with the study of the wording and content of the suggested Constitution and By-Laws.)

Article I

Sec. 1. Many suggestions have been received that the name of the Society be changed. A post-card poll (which will include several names, including the present) of the entire membership will be made before the St. Louis Meeting to guide the Council in its action.

Sec. 2. This section is included to satisfy certain legal requirements if the proposals are adopted.

Sec. 3. The statement of objectives of the Society has been expanded to completely describe its present activities.

Article II (Membership)

Sec. 3. Because of the difficulties of obtaining a unanimous ballot from Council within a reasonable time, and because of the contrariness of Man, the suggestion is made that a favorable vote of three-fourths of Council shall be sufficient for election of Honorary members.

Sec. 8. A new grade of "Affiliate" has been added to the Institutional Memberships to include certain Junior colleges, Technical Institutes, etc. The Associate grade is now limited to certain professional groups.

Sec. 9, 10, 11, 12. The specifications for Institutional membership have been carefully expanded to meet the needs of S.P.E.E., E.C.R.A. and the Division of Administrative Officers. In Sec. 10, at this time the sum prescribed in the By-Laws of E.C.R.A. is a minimum of $10,000 which was spent for research for the three years ($3333 per year) prior to the application.

Article III (Organization)

An Article has been included to better define the functions of the proposed groups as shown partially on the Organization Chart.

Article IV (Officers)

Examination of the proposed organization shart shows that the President of the Society is Chairman both of the General Council and the Executive Board.

Four Vice Presidents of the Society are proposed, namely: Vice President in charge of General and Regional Activities (Sections and Branches); Vice President in charge of Instructional Divisions (Aeronautics, Chemistry, Economics, Mathematics, etc.); Vice President representing E.C.R.C. who is the Chairman of E.C.R.C.; and the Vice President representing E.C.A.C. who is the Chairman of E.C.A.C.

Thus the duties and responsibilities of the Vice Presidents are more definitely prescribed than in the present constitution. A two-year term is proposed for all Vice Presidents for the sake of continuity and to give sufficient time to permit the fulfillment of programs initiated.

Article V (Executive Board)

Sec. 3. This section provides a framework for action which was lacking during the war and thus will permit quick consolidated efforts by the Society should another emergency arise.

Sec. 4. The Executive Board normally maintains the checks and balances, guides the activities, and prevents duplication of effort of the four groups. However, there may be times when instant action is desirable, particularly when National Legislation is underway or Congressional Hearings are to be held; in such cases (for example: Selective Service as it affects engineering students; National Research Foundation Bills as they affect Engineering Colleges, etc.), the time factor is essential and each Council may take action in its natural field of activity.

Article VI (General Council)

Sec. 1. The General Council has been made more representative of the Divisions and Sections and hence probably made more diverse with respect to geographical area and field of interest. (There are 8 officers, 18 sections, and 16 divisions, thus making a total membership of 42 in the General Council under the proposed constitution.) There are approximately 25 living Past Presidents, and if all of these Past Presidents were members of the proposed General Council, the total membership of the proposed council would be 67. In order to form a more compact General Council the proposal is made to limit the number of Past Presidents on Council to the three Junior Past Presidents.

Article VII (Institutional Board)

The proposed formation of the Institutional Board with its constituent Engineering College Research Council and Engineering College Administrative Council is the mechanism by means

of which these latter two groups have been brought together under the one umbrella of our society. This mechanism through the instrumentation of the proposed constitution has been thoroughly discussed by all parties involved. Each group has sacrificed some autonomy in order to submit to the constitution as proposed. A most undesirable alternative would be to have three completely independent organizations in the field of Engineering Education, namely: S.P.E.E., E.C.R.A. and E.C.A.C.

Article VIII (E.C.R.A.)

This article has been composed by consultation with members of E.C.R.A. and has been approved by that organization.

Article IX (E.C.A.C.)

This article has been formed by consultation with members of the Division of Engineering College Administrative Officers.

Article X (Sections, Branches and Divisions)

Sec. 4. The function of a Division has been clarified and the method of initiating a Division is explained.

Article XI (Election of Officers)

Sec. 3. The selection of the General Council members by the sections and branches has already been prescribed in Article VI, Section 1.

Article XII (Dues)

Sec. 2. Dues of individual members cannot be changed unless a letter ballot of the entire membership confirms such change.

Article XIII (Meetings)

The proposed constitution gives to the Executive Board the power to determine the time and place of the next Annual Meeting, provided that the Society has not made this decision, in order that a selection may be made efficiently after a national emergency period during which no meetings were held.

The power of authorizing the time and place of Division and committee meetings has been given to the Executive Committee of the General Council in orded to minimize possible conflicts in time with other activities of the Society.

Article XV (Amendments)

The present constitution permits a two-thirds majority of a possibly small number of members actually present at a regular meeting to ratify amendments. The proposed constitution presents a fairer method of requiring a two-thirds majority of a letter ballot of all members of the Society, whether present or not at a regular meeting. The 30-day limit is considered necessary in order that the ballots will be returned promptly.

Submission of proposed amendments to the councils and notice of the actions taken by them on the amendment in question will assist the individual voting member in determining the value and need of the proposed amendment.

By-Laws of the Society

First. The Executive Board really constitutes the "Officers of the Society" under the present constitution.

Second. The proposed constitution offers a more definite manner of preparing and presenting the annual budget than the present constitution.

Third. A definite method of making expenditures is established.

Fourth. The proposed individual member dues are identical with those now in effect.

The dues for the Institutional membership are recommended by the members of E.C.R.A. and E.C.A.C. who consulted with the Committee on Revision of the Constitution.

Fifth. A definite "Business" year is recommended.

Seventh. The responsibility for the appointment of committees has been decentralized and is given to the group concerned.

Eighth. E.C.R.A. and E.C.A.C. already have publications which are independently published and financed. E.C.R.A. in particular expects to expand their publications in the near future. The funds required for such an expansion will of course come from the fees received from the E.C.R.C. Institutional Membership funds.

Ninth. With the exception of the dues of the individual membership, the By-Laws may be changed at any regular meeting provided the proposal has been submitted to the Council for examination. An alteration in the amount of dues of the individual membership requires a letter ballot of all members.

Summary

A brief history of the events leading to the proposed revision of the Constitution has been given. Brief explanations of the proposed changes have been presented. It is the hope of the Committee on Revision that all members of the Society will carefully study the proposed Constitution and discuss with other members the complicated problems involved, so that the membership may be well prepared to act upon the proposals at the June meeting of the Society.

CONSTITUTION.

ARTICLE I.

NAME AND OBJECTS.

1. The name of this organization shall be the Society for the Promotion of Engineering Education.

2. The objects of this Society shall be the promotion of the highest ideals in the conduct of engineering education with respect to administration, curriculum, and teaching work, and the maintenance of a high professional standard among its members. The means to this end shall include educational research, the holding of meetings for the reading and the discussion of professional papers, and the publication of papers, discussions, and communications as may seem expedient.

On the left hand page will be found the present Constitution and By-Laws of the Society in sequential order. On the right hand page will be found the proposed amendments to the articles of the existing Constitution and By-Laws.

These amendments are, however, numbered according to the sequence they will follow in the proposed revised Constitution and By-Laws.

Continued on page 476.

ARTICLE I.

NAME AND OBJECTS.

Section 1. The name of this organization shall be (name to be determined by the Society at the Annual Meeting after a straw vote by mail of the individual membership).

Section 2. The Society shall be a continuation of the Society for the Promotion of Engineering Education and its organization and purpose shall be expanded so as to include those of the Engineering College Research Association.

Section 3. The purpose of this Society shall be the advancement of education in all its functions which pertain to engineering and allied branches of science and technology, including the processes of teaching and learning, research, extension services, and public relations. The Society shall serve its members as a common agency of stimulation and guidance in: (*a*) the formulation of the general goals and responsibilities of engineering education for the service of individuals and the advancement of general welfare, (*b*) the adjustment of curricula and educational processes to changing conditions; (*c*) the development of effective teachers and administrators; (*d*) the improvement of instructional materials and methods, of personnel practices, and of administrative usages; (*e*) the enhancement of professional ideals and standards; (*f*) the fostering of research as a function collateral to teaching; (*g*) the coordination of institutional aims and programs, both among schools and colleges and in their joint relations with professional, educational, and public bodies; and (*h*) the cultivation of a fraternal spirit among teachers, administrators, investigators, practitioners, and industrialists.

Note: Item (*h*) The committee would prefer the present language, but it has been suggested that the word "fraternal" might be undesirable from a legal point of view in connection with tax exemption. Hence if legal counsel objects to the present language, the committee would suggest the following: "and (*h*) the cultivation of a spirit of cooperation and fellowship among teachers, administrators, investigators, practitioners, and industrialists."

ARTICLE III.

ORGANIZATION.

Section 1. The means to ends specified in Article I, section 3, shall include the establishment of subordinate units of organization as needed to serve local, regional, departmental, or functional interests, the holding of meetings, conferences, and special schools, the setting up of agencies for educational inquiry, research, or planning, and the publication of papers, reports, researches, communications, and other significant materials concerned with engineering education.

Section 2. The Society shall be an organization of individual and institutional members and shall operate in two coordinate areas of activity corresponding to the respective interests of these groups. Its general activities shall be administered by an Executive Board (see Article V). The activities

Continued on page 477.

ARTICLE II.

MEMBERSHIP.

Membership in the Society shall be of two general classes, Institutional and Individual.

Institutional members shall be of two classes, active and associate. The active institutional members shall be recognized institutions giving baccalaureate or equivalent degrees for curriculums in engineering, and distinguished national professional engineering societies. Associate members shall be other educational institutions giving instruction in engineering. Institutional members shall be entitled to representation at all meetings of the Society or its divisions by regularly appointed delegates, one for each institutional member concerned.

Individual membership shall be of two classes, Active and Honorary. It shall comprise those persons who occupy or have occupied responsible positions in the work of engineering instruction, engineering practitioners, and other persons interested in engineering education.

Honorary members of the Society shall be such persons as may be recommended by unanimous vote of the Council in a letter ballot to be taken by the Secretary on the recommendation of twenty members of the Society in the manner provided hereinafter for proposals for individual members. Councilors not heard from within one month from the date of mailing the ballots will be counted in favor of the candidate. Honorary members shall not have the right to vote, shall not be eligible to office, and shall not be required to pay any fees or dues.

A member in good standing may become a life member, exempt from all future payments for dues, by a single payment of an amount equal to twenty times the annual dues. Such payments received by the Society shall be placed in a separate fund known as the Life Membership Fund. The interest earned on this fund shall be used as current income.

An individual member who has been in good standing for twenty-five years or more, who has reached the age of 65 years, and who has retired from active professional life, may, upon written request, be designated as a life member by vote of the Council, and shall thereafter be exempt from the payment of dues.

The name of each candidate for active individual membership shall be proposed in writing to the Secretary by two members by whom the candidate is personally known. The proposal shall state the qualifications on which it is based. The name of a candidate for institutional membership shall be proposed by any member familiar with the work of the institution, on receipt of an application signed by a responsible officer thereof. An affirmative letter ballot of three-fourths of those members of the Council whose votes reach the

Continued on page 478.

of its individual members shall be conducted under a General Council (see Article VI) and the activities of its institutional members through an Engineering College Research Council (see Article VIII) and an Engineering College Administrative Council (see Article IX). An Institutional Board (see Article VII) shall coordinate the activities of the two Councils of the institutional members.

The individual members of the Society shall further be organized in groups to function as (*a*) sections in specified territories; (*b*) branches formed by members of single institutions and (*c*) divisions with important subjects of instruction or research, under provisions as hereinafter set forth.

ARTICLE II.

MEMBERSHIP.

Section 1. Membership in the Society shall be of two general classes, Individual and Institutional.

Section 2. Individual membership shall be of two classes, Active and Honorary. It shall comprise those persons who occupy or have occupied responsible positions in engineering instruction, research, or practice, and other persons interested in engineering education.

Section 3. Honorary members of the Society shall be such persons as may be approved by a favorable vote of at least three-fourths of the members of the General Council in a letter ballot to be taken by the Secretary on the recommendation of twenty members of the Society in the manner provided hereinafter for proposals for individual members. Councilors not heard from within one month from the date of mailing the ballots will be counted in favor of the candidate. Honorary members shall enjoy all the privileges of the Society excepting the right to vote, and to hold office, and shall not be required to pay any fees or dues.

Section 4. A member in good standing may become a life member, exempt from all future payments for dues, by a single payment of an amount equal to twenty times the annual dues for members. Such payments received by the Society shall be placed in a separate fund known as the Life Membership Fund. The interest earned on this fund shall be used as current income.

Section 5. An individual member who has been in good standing for twenty-five (25) years or more, who has reached the age of sixty-five (65) years, and who has retired from active professional life, may, upon written request, be designated as a life member by vote of the General Council, and shall thereafter be exempt from the payment of dues.

Section 6. The name of each candidate for active individual membership shall be proposed in writing to the Secretary by two members by whom the candidate is personally known. The proposal shall state the qualifications on which it is based. An affirmative letter ballot of three-fourths of those members of the General Council whose votes reach the Secretary within one month from the time of sending out the name of the candidate shall elect.

Section 7. Institutional members shall be of three classes: Active, Associate, and Affiliate. Active members shall be institutions which are eligible to participate in either or both of the institutional membership Councils. Associate members shall be professional organizations of engineers, research institutions, and industrial associations or organizations which have

Continued on page 479.

Secretary within one month from the time of sending out the name of the candidate shall elect. Such letter ballot elections, occurring before February 1, shall be credited to the previous annual meeting and dues shall date from that time; elections occurring after February 1 shall be credited to the next annual meeting and the dues for the remainder of the year shall be one-half the annual dues.

ARTICLE III.

Dues.

1. There shall be no admission fee.

2. The annual dues shall be as stated in the By-Laws.

3. Dues are payable in advance at the time of the annual convention, and become delinquent at the end of the fiscal year for which they are assessed. Dues of new members are payable at the time of election, and become delinquent at the end of the fiscal year within which the members are elected.

4. Members in arrears one year shall be retained on the roll of the Society, but shall not receive publications until such time as all arrearages are paid. Members in arrears two years, and who have been duly notified by the Secretary, shall be dropped from the roll of the Society until such arrearages are paid. The Secretary shall notify all members in arrears one month previous to the close of the fiscal year. The fiscal year shall terminate on the thirtieth day of June.

Continued on page 480.

a major interest in engineering education. Affiliate members shall be other educational institutions engaged in technical instruction and which have one or more curricula accredited by Engineers' Council for Professional Development or which are accredited by a major regional educational association.

Section 8. Active member institutions shall be only those offering curricula leading to baccalaureate or higher degree in engineering and having one or more curricula accredited as such by Engineers' Council for Professional Development, or if not within its jurisdiction must have one or more engineering curricula whose standards as judged by a competent accrediting agency are not lower than those of that Council. In the absence of any such accrediting agency the Executive Board of the Society shall have the power to judge of the equivalence of standards.

Section 9. All institutions which meet the conditions described in section 9 shall be eligible to participate as voting members in the Engineering College Administrative Council. To be eligible for voting participation in the Engineering College Research Council it is further required that the institution's research organization or activity shall have existed for at least three (3) years and shall have expended for engineering research during the three (3) fiscal years next preceding the date of its admission to the Council not less than that sum prescribed in the bylaws of the Engineering College Research Council.

Section 10. An institution may be proposed for membership by an official representative of any member institution who is familiar with the work of the Institution proposed; or application for admission may be made directly by a responsible officer of the institution concerned. In either case the proposal or application shall be made in writing, addressed to the Secretary of the Society, and shall indicate the grade of membership applied for and the Council or Councils in which it wishes to participate.

Section 11. The Executive Board shall determine the eligibility of the applicant for membership of any class in the Society and shall thereupon refer the application to the Institutional Board. The latter body shall have the power to elect Associate and Affiliate members of the Society by letter ballot, but shall refer applications for Active membership to the Executive Committee of each of the Councils in which the applicant desires to participate, each such Executive Committee being empowered to admit the applicant to the Council which it represents. All elections shall require a two-thirds favorable vote of the ballots cast. Institutions thus elected to membership in either or both of the institutional Councils thereby become Active institutional members of the Society.

ARTICLE XII.

Dues.

Section 1. There shall be no admission fee.

Section 2. The annual dues shall be as stated in the Bylaws of the Society, and any change in the dues of individual membership shall be determined by letter ballot of such membership.

Section 3. A member elected prior to February 1 in any fiscal year shall pay the full dues of that year; if elected after February 1, he shall pay half the dues of that year.

Section 4. Dues are payable in advance at the beginning of each fiscal year and shall be considered in arrears if not paid by the end of the fiscal year for which they are assessed. Dues of new members are payable at the time of election and shall be considered in arrears if not paid by the end of the fiscal year within which they are elected.

Continued on page 481.

ARTICLE IV.

Officers.

There shall be a President, a First Vice President, and a Second Vice President, each to hold office for one year. There shall be a Secretary and a Treasurer, both to be appointed by the Council. In case of a vacancy in the office of President, the First Vice President shall succeed to that office. In case of a vacancy in the office of First Vice President, the Second Vice President shall succeed to that office.

Continued on page 482.

Section 5. Members in arrears one year shall be retained on the roll of the Society, but shall not receive publications until such time as all arrearages are paid. Members in arrears two years, and who have been duly notified by the Secretary, shall be dropped from the roll of the Society until such arrearages are paid. The Secretary shall notify all members in arrears one month previous to the close of the fiscal year.

ARTICLE IV.

Officers.

There shall be a president, who shall be the executive officer of the Society and who shall hold office for one year. There shall be four Vice Presidents, each to hold office for two years, as follows: in connection with the individual membership, a Vice President responsible for General and Regional Activities, and a Vice President responsible for Instructional Divisions, to be elected in alternate years; in connection with institutional membership, a Vice President responsible for the Engineering College Research Council, and a Vice President responsible for the Engineering College Administrative Council, to be elected in alternate years. There shall be a Secretary, to be appointed annually by a Committee consisting of the President and all Vice Presidents; and a Treasurer, to be elected annually. In case of a vacancy in office of the President, the Vice President for General and Regional Activities shall succeed to that office. In case of a vacancy in the office of the Vice President for General and Regional Activities, the Vice President for Instructional Divisions shall succeed to that office.

ARTICLE V.

Executive Board.

Section 1. The Executive Board of the Society shall consist of the President, the four Vice Presidents, the Secretary, and the Treasurer. Its function shall be to coordinate the activities of the Society. Its actions shall be final as to (*a*) approval of budgets, (*b*) authorization of publications, (*c*) conventions, (*d*) appointment of officers to fill emergency vacancies, and (*e*) determination of eligibility of institutional members. In all other matters, however, the Executive Board is advisory to the General Council, the Engineering College Research Council, and the Engineering College Administrative Council.

Section 2. The procedure in (*d*) filling emergency vacancies shall be as follows: excepting the Secretary, whose appointment is otherwise provided herein, the Executive Board shall make the appointment on recommendation of the President; provided, however, that, in case of vacancy in the office of a Vice President associated with the institutional membership, the President shall transmit to the Executive Board the recommendation of the Executive Committee concerned. The term of emergency appointments shall be until a successor is regularly elected.

Section 3. In case of a national emergency during which it is impossible for the Society to hold a regular meeting, the Executive Board may take any action on behalf of the Society that it deems necessary and advisable; provided, however, that such action shall be reported to the Society at its first regular meeting thereafter.

Section 4. Each Council of the Society shall report all of its actions to the Executive Board and shall not take an action affecting the interests of

Continued on page 483.

Continued on page 484.

another Council until such proposed action has been considered by the Executive Board; provided, however, that in cases where the time element is too critical to permit deliberation by the Executive Board, a Council may, on its own responsibility, take emergency action within its own domain, or if it so authorizes, its Executive Committee may take such action; or provided further that a Council, or its Executive Committee if so authorized, may take such action jointly with another Council where joint interests are involved.

ARTICLE VII.

Institutional Board.

Section 1. There shall be an institutional Board of twenty members, ten of whom shall represent the Engineering College Research Council and ten, the Engineering College Administrative Council, including in each group the Vice President associated with the Council and such members of its Executive Committee appointed by this Committee; provided that in case the membership of the Executive Committee is less than the required number, this Committee shall appoint the necessary additional delegates. The Senior Vice President included is to serve as Chairman of the Institutional Board.

Section 2. The functions and powers of the Institutional Board shall be such as are assigned to it by the two constituent Executive Committees and to elect institutional members as provided in Article II, section 12.

ARTICLE VIII.

Engineering College Research Council.

Section 1. There shall be an Engineering College Research Council whose purpose shall be to assist in developing the research facilities of engineering colleges (*a*) to further advanced study in colleges of engineering and to develop and coordinate industrial and scientific research; (*b*) to undertake research designed to promote engineering advancement and economic adjustment in industry, public works, public health, the conservation and development of natural resources, and similar activities; (*c*) to cooperate with other associations and government agencies in the prosecution and promotion of research and to collaborate with them to prevent duplication of effort and achieve maximum utilization, coordination, and development of engineering and scientific research facilities; and (*d*) to publish periodic research reports, studies, papers, and investigations of significant value to engineering colleges and cooperating research agencies.

Section 2. Its membership shall consist of one duly appointed representative for each such Active Institutional Member and Associate Institutional Member (non-voting) as are admitted by the Engineering College Research Council; provided, however, that the original Active and Associate Institutional Members shall be those which are respectively Active and Associate Members of the Engineering College Research Association at the time the (name not yet determined) is formally organized.

Section 3. There shall be an Executive Committee of, and constituted by, the Engineering College Research Council; provided, however, that the Vice President of the Society associated with this Council shall be President of the Council; and the President, Treasurer, and Secretary of the Society shall be ex officio advisory members without vote; and its powers shall be those delegated to it by this Council.

Continued on page 485.

ARTICLE V.

Council.

1. The Council of the Society shall consist of twenty-one elective members, one-third of whom shall retire annually, and the officers and the past presidents of the Society.

2. Any individual member of the Society shall be eligible to election to the Council, provided that not more than one elective member shall be from the faculty of any one institution.

3. The elective officers and members of the Council shall continue in office for a period of ten (10) days after their successors shall have been elected.

Continued on page 486.

Section 4. The Engineering College Research Council shall determine its own Bylaws which shall conform to the Constitution and Bylaws of the Society.

ARTICLE IX.

Engineering College Administrative Council.

Section 1. There shall be an Engineering College Administrative Council whose purpose shall be (*a*) to relate the engineering colleges to public welfare by close cooperation with the agencies of the Government; (*b*) to bring about cooperation among engineering colleges in the interest of the engineering profession, industry, and the public at large; (*c*) to bring about cooperation between the engineering colleges of this country and those of other lands; (*d*) to cooperate with engineering societies, trade organizations, and commercial groups in the interest of engineering education; (*e*) to act as an instrument of inquiry into problems which contribute to effective administration of engineering colleges; (*f*) to make the public conscious of the value of engineering education as a preparation for service to society in a technologic civilization.

Section 2. Its membership shall include one duly appointed representative of each such Active Institutional Members and Associate Institutional Members (non-voting) as are admitted to the Engineering College Administrative Council; provided, however, that the original Active and Associate Institutional Members shall be those which are respectively institutional and associate members of the Society for the Promotion of Engineering Education at the time the (name not yet determined) is formally organized.

Section 3. There shall be an Executive Committee of, and constituted by, the Engineering College Administrative Council; provided, however, that the Vice President of the Society associated with this Council shall be President of the Council; and the President, Treasurer, and Secretary of the Society shall be ex officio advisory members without vote; and its powers shall be those delegated to it by this Council.

Section 4. The Engineering College Administrative Council shall determine its own Bylaws which shall conform to the Constitution and Bylaws of the Society.

ARTICLE VI.

General Council.

Section 1. The General Council of the Society shall consist of the President, who shall be chairman, the two Vice Presidents associated with the individual membership, the Secretary, the Treasurer, the three Junior Past Presidents, and a representative of every Division and Section elected by the body concerned for a term of two years according to a plan of rotation in which one half of such representatives will be chosen each year.

Section 2. Any individual member of the Society shall be eligible for election as such a representative on the General Council.

Section 3. The elective officers and members of the Council shall continue in office for a period of ten (10) days after their successors shall have been elected.

Section 4. The actions of the General Council shall be final on all matters concerning the General and Regional Activities and the Instructional Divisions, excepting those herein delegated to the Executive Board.

Continued on page 487.

ARTICLE VI.

Election of Officers and Members of the Council.

1. The President, the two Vice Presidents, and one-third of the elective members of the Council shall be elected each year from the individual membership by ballot of the Society at the annual meeting.

2. There shall be a Nominating Committee consisting of the past presidents, the members of the Council retiring the following year, and one member of the Society from each Section, who shall have been elected for a term of one year at a regularly called meeting of the Section and duly certified to the Secretary of the Society before May 15. If, however, the total number of committee members attending any meeting of the Committee for official action be less than five, the President shall appoint a sufficient number to form a committee of five. The Committee shall report to the Society, at the business session provided therefor in the program, its nominations of officers for the ensuing year and of councilors for three-year terms and for any incomplete terms necessary to fill vacancies.

The senior Past President present at the opening of the committee meeting shall serve as its chairman.

Members of the Council who are serving the first year of their terms shall be invited by the Secretary to attend the meetings of the Nominating Committee as observers without voice.

By means of a form to be printed in The Journal of Engineering Education or in the preliminary program of the annual meeting, an opportunity shall be given to individual members of the Society to submit names of persons to be considered for officers and for the Council. These names, on the form provided, shall be sent to the Secretary of the Society not later than May 15; and, as soon thereafter as possible, the Secretary shall send the suggested names to all members of the Nominating Committee.

ARTICLE VII.

Sections, Branches and Divisions.

1. A Section of the Society may be formed by members in two or more institutions, or by the members within a prescribed territory. A Section may be formed in any locality by a temporary organization which shall become a duly authorized section of the Society upon the approval of the Council. Sections may determine their own form of organization, but shall operate in conformity with the Constitution and the By-Laws of the Society and shall make a report of their proceedings to the Secretary of the Society. Sections shall be self-sustaining.

2. A Branch may be formed in any institution by a temporary organization which shall become a duly authorized Branch of the Society upon approval by the Executive Committee. Branches may determine their own form of organization, but shall operate in conformity with the Constitution and the

Continued on page 488.

Section 5. There shall be an Executive Committee of, and constituted by, the General Council, provided, however, that the President, Treasurer, and Secretary of the Society shall be ex officio full members; and its powers shall be those delegated to it by the General Council.

Section 6. The General Council shall determine its own Bylaws which shall conform to the Constitution and Bylaws of the Society.

ARTICLE XI.

Election of Officers.

Section 1. The President, Treasurer and two Vice Presidents shall be elected by ballot of the individual membership of the Society from their number at the annual meeting. The President and Treasurer shall be elected annually and the two Vice Presidents associated with individual membership shall be elected in alternate years for respective terms of two years. The two Vice Presidents associated with institutional membership shall be elected at the annual meeting of the Society in alternate years for respective terms of two years by their respective Councils. As an exception to the above provision, the Vice President associated with General and Regional Activities and the Vice President associated with the Engineering College Research Council, who are elected immediately following the adoption of this constitution, shall be elected for a one-year term and shall be the Senior Vice Presidents.

Section 2. There shall be a Nominating Committee consisting of the three Junior Past Presidents, senior member to be chairman, and those General Council members elected by the Sections whose terms expire in the year in which the annual meeting is held; provided, however, that the Nominating Committee for the first year of operations of this Society shall be the Nominating Committee provided for in the constitution of the Society for the Promotion of Engineering Education as of June 1, 1946.

Section 3. By means of a form to be printed in The Journal of Engineering Education or in the preliminary program of the annual meeting, an opportunity shall be given to individual members of the Society to submit names of persons to be considered for said officers. These names, on the form provided, shall be sent to the Secretary of the Society not less than sixty (60) days prior to the annual meeting; and the Secretary shall submit the suggested names to all members of the Nominating Committee.

ARTICLE X.

Sections, Branches, and Divisions.

Section 1. A section of the Society may be formed by members in two or more institutions within a territory prescribed by the General Council. A Section may be formed by a temporary organization which shall become a duly authorized section of the Society upon the approval of the General Council. Sections may determine their own form of organization, but shall operate in conformity with the Constitution and the Bylaws of the Society and shall make a report of their proceedings to the Secretary of the Society. Sections shall be self-sustaining.

Section 2. A Branch may be formed by members in any institution by a temporary organization, which shall become a duly authorized Branch of the Society upon approval by the Executive Committee of the General Council. Branches may determine their own form of organization, but shall operate in

Continued on page 489.

By-Laws of the Society and shall make a report of their proceedings to the Secretary of the Society. Branches shall be self-sustaining.

Branches may coöperate with, or be a part of, other organizations having the same general purposes as this Society. The general purpose of Branches is to extend the interest in, and the discussion of, questions relating to the teaching of engineering students and to bring to the Society at large, through its publications, the activities in all institutions that will be serviceable to the members of the Society.

3. Papers and discussions presented before Sections or Branches shall be the property of the Society and may be published as Society proceedings if authorized by the Publication Committee. Permission to publish elsewhere may be granted by the Council on condition that the Society receives proper credit.

4. When approved by the Council, Divisions may be formed by any group of members for the consideration of questions which relate particularly to that group.

ARTICLE VIII.

Meetings.

There shall be at least one annual meeting at such time and place as the Society at the preceding meeting, or the Council, if the Society does not act, may determine. There shall be sectional and branch meetings as the members of the different sections and branches may determine.

ARTICLE IX.

Publications.

1. The formal publications of the Society shall be a monthly journal to be published from September to June, inclusive, and a year book. The *Journal* shall contain the proceedings of the annual convention, and such other pertinent papers as may be submitted to, and approved by, the Publication Committee. A bound volume of the *Journal* for each current year shall constitute the *Proceedings* of the Society.

2. Each individual member, not in arrears, shall receive the *Journal*. Each institutional member shall be furnished with two copies of the *Journal* and two copies of the *Proceedings* of the Society.

Volumes of the *Proceedings* will be sold to members who subscribe for them at a cost to be determined each year by the Executive Committee. Subscriptions for the *Proceedings* must be received in advance by the Secretary on or before October 15 of each academic year.

Continued on page 490.

conformity with the Constitution and the Bylaws of the Society and shall make a report of their proceedings to the Secretary of the Society. Branches shall be self-sustaining.

Branches may cooperate with, or be a part of, other organizations having the same general purposes as this Society. The general purpose of Branches is to extend the interest in, and the discussion of, questions relating to the teaching of engineering students and to bring to the Society at large, through its publications, the activities in all institutions that will be serviceable to the members of the Society.

Section 3. Papers and discussions presented before Sections or Branches shall be the property of the Society and may be published as Society proceedings if authorized by the Publication Committee. Permission to publish such papers and discussions elsewhere may be granted by the Executive Committee of the General Council on condition that the Society receives proper credit.

Section 4. The General Council may establish Divisions of the Society in areas of instructional responsibility generally existing in engineering colleges, e.g., mathematics, electrical engineering. Divisions may be formed either on the initiative of the General Council or upon petition of a group of members concerned.

Section 5. The Executive Board, the General Council, the Engineering College Research Council, and the Engineering College Administrative Council may establish committees in their respective domains as prescribed in the Bylaws.

ARTICLE XIII.

Meetings.

There shall be at least one annual meeting at such time and place as the Society at the preceding meeting, or the Executive Board, if the Society does not act, may determine. The Executive Committee of the General Council shall authorize the time and place of meetings held under the auspices of Divisions and Committees excepting those held at national conventions of the Society.

ARTICLE XIV.

Publications.

The Executive Board shall authorize all official publications of the Society and shall also prescribe the rights of the several grades of members in connection with these publications.

Continued on page 491.

ARTICLE X.

AMENDMENTS.

This Constitution may be amended by a two-thirds vote of those present at any regular meeting of the Society, provided that all members have been notified of the proposed amendment by notices mailed from the Secretary's office at least 30 days prior to the regular meeting at which action is had, and provided that the amendment shall have been approved by the Council by a two-thirds vote of the members voting by letter or voice.

BY-LAWS OF THE SOCIETY AND RULES GOVERNING THE COUNCIL.

First. The officers of the Society shall constitute a committee to arrange for the annual meeting and to prepare a program for it.

Second. The President, the two Vice-Presidents, the Secretary, and the Treasurer shall constitute an Executive Committee which shall have charge of all matters relating to the expenditure of money of the Society, the making of contracts, the approval of bills, and also during the period between the meetings of the Council shall have charge of other business affairs of the Society.

Third. Expenditures of money may be made only in accordance with a definite appropriation or by direct vote of the Executive Committee.

Fourth. The annual dues shall be $5.00 for individual members, and $15.00 for institutional members.

Fifth. Reading of papers shall be limited to fifteen minutes each, or to such other time as may be designated by the Program Committee, and abstracts of papers of about three hundred words shall be printed when practicable, and distributed in advance to the members.

Sixth. The time occupied by each person in the extemporaneous discussion of any paper shall not exceed five minutes.

Seventh. The President, the Secretary, and the retiring president shall constitute a Publication Committee, of which the Secretary shall be chairman, to edit and to have charge of the publication of the monthly *Journal*.

Eighth. The subscription price of the *Journal* shall be three dollars per year, payable in advance.

Ninth. Any educational institution which has one or more of its curriculums accredited by the Engineers' Council for Professional Development shall be considered as "recognized" within the meaning of the constitutional requirement for active institutional membership, and no other educational institution within the United States or its territorial possessions shall be so considered.

Tenth. Any engineering degree-granting educational institution in continental North America, outside of the United States, shall be considered as "recognized":

(*a*) If one or more of its engineering curriculums have been accredited by an agency whose standards are adjudged by the Council of the Society to be not lower than those of the Engineers' Council for Professional Development, or

(*b*) If no suitable accrediting agency is available to appraise its engineering curriculums, but one or more of these curriculums are adjudged by the Council of the Society, upon satisfactory evidence, to meet standards not lower than those of the Engineers' Council for Professional Development.

Eleventh. Any Junior College or other educational institution giving instruction which is adjudged by the Council of the Society, upon satisfactory

Continued on page 492.

ARTICLE XV.

AMENDMENTS.

This constitution may be amended by a favorable vote of the individual members of the Society, the proposed amendment being approved if at least two-thirds of the ballots returned within thirty (30) days after they are mailed out are favorable; and provided further (*a*) that the proposed amendment has first been voted upon by each of the three Councils of the Society and (*b*) that the results of such votes be recorded in the notice sent out to the membership with the ballots.

BY-LAWS OF THE SOCIETY.

First. The Executive Board shall arrange for the annual meeting and prepare a program for it.

Second. Each Vice President shall submit a proposed budget for the activities for which he is responsible, to the Executive Board through the Secretary, who shall incorporate it with the General Budget so that the total proposed budget may be submitted to the Executive Board before May 1. It is provided, however, that the Engineering College Research Council budget, in first year only, shall be based on $35 for each Active and Associate Institutional Member affiliated with the E. C. R. C.

Third. Disbursements from the funds of the Society shall be made by the Treasurer in accordance with the approved budget or a direct appropriation authorized by the Executive Board for a special purpose, and upon vouchers signed by the Secretary of the Society.

Fourth. The annual dues shall be as follows:

Individual members, $5.00
Institutional members
1. Active Members
   a. participating in both Institutional Councils, $50.00
   b. participating in only one Institutional Council, $35.00
2. Associate Members, $50.00
3. Affiliate Members, $25.00

Fifth. The fiscal year of the Society shall be July 1 to June 30.

Sixth. The Secretary of the Society shall be secretary of the Executive Board.

Seventh. Committees, excepting the Executive Committees, reporting to the Executive Board and to the General Council shall be authorized by these respective bodies and appointed by the President. Committees reporting to either of the institutional Councils shall be authorized by the Executive Committee concerned and be appointed by the Vice President concerned. Committees of Sections, Branches, or Divisions shall be authorized by the body concerned and be appointed by the Chairman of the body concerned.

Eighth. There shall be a Publication Committee consisting of the President, junior Past President, and the Secretary of the Society who shall be chairman. It shall be responsible to the Executive Board for the general administration of all official publications of the Society.

The Secretary of the Society shall have direct charge and be editor of all publications authorized by the Executive Board excepting those so authorized for the Engineering College Research Council and the Engineering College Administrative Council, which shall be edited and published in accordance with plans of procedure recommended by these respective Councils and ap-

Continued on page 493.

evidence, to be substantially equivalent to the first two years of one or more curriculums accredited by the Engineers' Council for Professional Development shall be considered as among those institutions "giving instruction in engineering" within the meaning of the constitutional requirement for associate institutional members.

Twelfth. Additions or amendments may be made to these By-Laws at any regular meeting of the Society by a two-thirds affirmative vote of the membership present at the business session, provided that the additions or amendments shall have been approved by a two-thirds affirmative vote of the Council membership in attendance at the meeting, and shall have been recommended by that body for adoption.

proved by the Executive Board; provided, however, that the plans shall include a Subcommittee of the Publication Committee for each of said Councils, the personnel of the Subcommittee to be recommended by the Council concerned and approved by the Executive Board.

The selling price of all publications shall be determined by the Executive Board on recommendation of the Publication Committee.

All income from publications shall be classified as income of the Society applicable to the annual budget of the Society.

Ninth. These Bylaws, excepting as they relate to dues of individual members, may be amended by a two-thirds vote of the members present at any regular meeting of the Society, provided that all individual and institutional members have been notified of the proposed amendment by notices mailed by the Secretary's Office at least thirty (30) days prior to the said regular meeting at which action is to be taken, and provided further that the proposed amendment has first been voted upon by each of the three Councils of the Society and the results of such vote recorded in the notice sent out for the meeting at which the proposed amendment is to be acted upon.

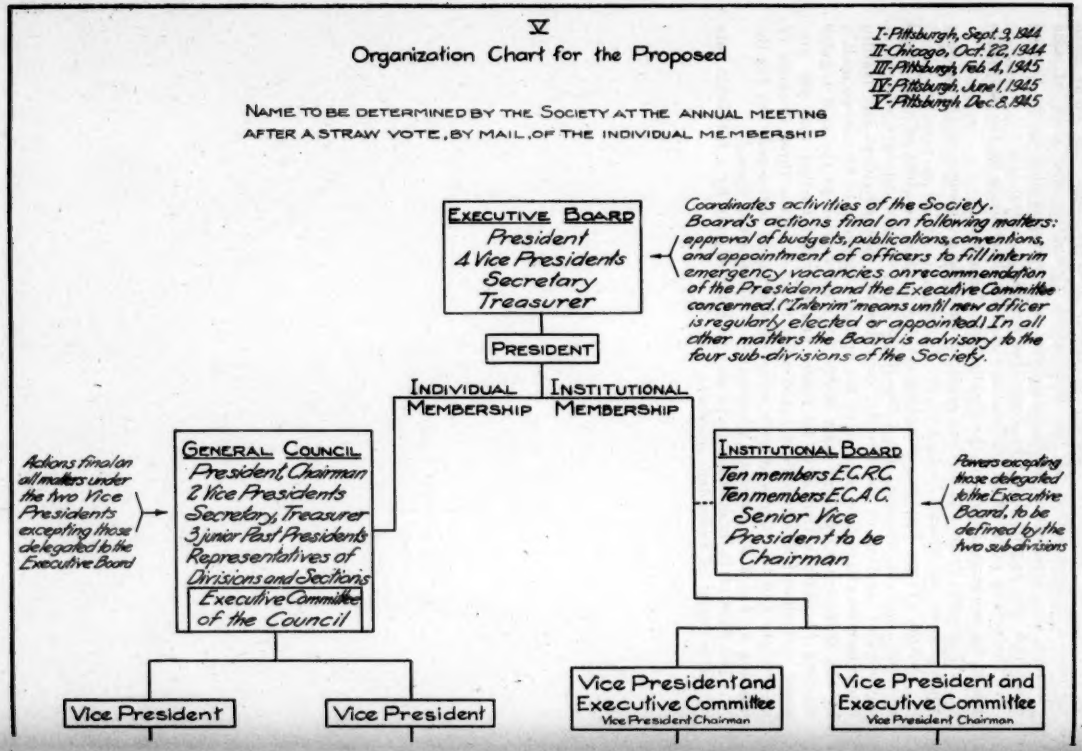
The dues of individual members may be changed only by a favorable vote by letter ballot of individual members.

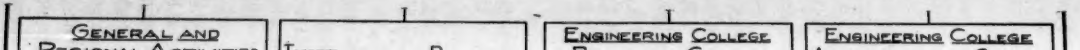
V

Organization Chart for the Proposed

I-Pittsburgh, Sept. 3, 1944
II-Chicago, Oct. 22, 1944
III-Pittsburgh, Feb. 4, 1945
IV-Pittsburgh, June 1, 1945
V-Pittsburgh, Dec. 8, 1945

NAME TO BE DETERMINED BY THE SOCIETY AT THE ANNUAL MEETING AFTER A STRAW VOTE, BY MAIL, OF THE INDIVIDUAL MEMBERSHIP


EXECUTIVE BOARD
President
4 Vice Presidents
Secretary
Treasurer
Coordinates activities of the Society. Board's actions final on following matters: approval of budgets, publications, conventions, and appointment of officers to fill interim emergency vacancies on recommendation of the President and the Executive Committee concerned. ("Interim" means until new officer is regularly elected or appointed.) In all other matters the Board is advisory to the four sub-divisions of the Society.
PRESIDENT
INDIVIDUAL MEMBERSHIP
INSTITUTIONAL MEMBERSHIP
Actions final on all matters under the two Vice Presidents excepting those delegated to the Executive Board
GENERAL COUNCIL
President, Chairman
2 Vice Presidents
Secretary, Treasurer
3 Junior Past Presidents
Representatives of Divisions and Sections
Executive Committee of the Council
INSTITUTIONAL BOARD
Ten members E.C.R.C.
Ten members E.C.A.C.
Senior Vice President to be Chairman
Powers excepting those delegated to the Executive Board, to be defined by the two sub-divisions
Vice President
Vice President
Vice President and Executive Committee
Vice President Chairman
Vice President and Executive Committee
Vice President Chairman



Vice President | Vice President | Vice President Chairman | Vice President Chairman

General and Regional Activities	Instructional Divisions	Engineering College Research Council	Engineering College Administrative Council
Membership and activities correspond to those in present Sections and Branches and in other groups exclusive of Instructional Divisions.	Membership and activities correspond to those in present Instructional Divisions-ie English, Mathematics, Engineering Drawing, etc.	Membership and activities correspond to those in present Engineering College Research Association.	Membership and activities correspond to those in present Division of Administrative Officers.

NOTES

1. **Budget:**
   a. Executive Board's action to be based on recommendations from the several Vice Presidents and the Secretary.
   b. Budget distribution in first year to be approximately the same as in previous year. The E.C.R.C. budget will be based, in first year only, on $35 for each "Full" and "Associate" institutional member.
2. **Dues:**
   a. Individual ($5).
   b. Institutional. Regular ($50), Associate ($25).
3. **Officers:**
   a. President. Elected annually by individual membership.
   b. Vice Presidents. Elected for 2 year terms, eligible for 2 terms.
      (1) Vice Presidents associated with General Council elected, in alternate years, by individual membership.
      (2) Vice Presidents associated with Institutional Council elected, in alternate years, by respective bodies concerned.
   c. Treasurer. Elected annually by individual membership.
   d. Secretary. Appointed by a committee consisting of the President and the 4 Vice Presidents.
4. **Committees:**
   a. Executive Committees to be constituted by the group concerned. The President and Secretary to be ex officio full members of the Executive Committee of the General Council; and ex officio advisory members, without vote, of the institutional Executive Committees.
   b. Committees, excepting Executive Committee, reporting to the Executive Board and to the General Council to be authorized by these respective bodies and appointed by the President.
   c. Committees reporting to the institutional Councils to be authorized by the Executive Committee concerned and appointed by the corresponding Vice President.
   d. Committees of Sections, Branches or Divisions to be authorized by the body concerned and appointed by the Chairman of the body concerned.
   e. The Nominating Committee to propose candidates for President and 2 General Council Vice Presidents only. It will be composed of 3 junior Past-Presidents, senior member to be Chairman, and those General Council members elected by the Sections whose terms expire in year of election.
5. **Emergency Action:**
   Power of emergency action delegated to the individual Executive Committees associated with either the institutional or individual membership in cases where the time element is too critical to permit deliberation by the Executive Board; such actions to be reported to the Executive Board.

If I Were an Engineer*

By RICHARD R. PRICE

Executive Secretary of the Minnesota Association of Professional Engineers

As a result of experience, observation and reflection, this is the advice I would give to neophyte engineers, middle-aged professionals, engineers-in-training and students preparing for a career in professional engineering. (I make no apology for the liberal use of the first person singular; this is a personal message.)

1. *If I were an engineer,* I would be a good engineer. This does not mean necessarily that I would design and build great central power plants, a Golden Gate Bridge or a Boulder Dam. But it does mean that within the limits of my congenital capacity, any construction for which I was responsible would be soundly designed, honestly built, functionally efficient and economical of operation; it also means that any underground or concealed members would stand critical inspection in the full light of day, "for the gods see everywhere." My works should always speak with the loud voice of integrity. To accomplish this I would seek and acquire adequate preparation and training; and I would not be in too much of a hurry to get started on a career.

In order to attain this objective I would be determined to attend the best engineering school I could find. The best is none too good as the foundation for a life-long career. At the end of the second year of schooling let the special branch or field of engineering which makes the strongest appeal to the student's taste and aptitudes be chosen. Here the danger of over-specialization is to be avoided. The thoughtful student should be seeking education as well as vocational training. He should be preparing to live richly and abundantly, as well as to make a living; and the former is by far the more important in the long run. Therefore the wise student will take only the minimum of required courses in his special field; he will have to live and grow in that area for the rest of his working life. He should fill up the rest of his program with courses in the other specialized fields of engineering. In that way he will acquire a valuable working knowledge of the whole area cultivated and serviced by the engineering profession. In later days he may be thankful that he has some insight into the problems confronting engineers in collateral branches of his vocation. Above all, I advise that he take a fifth year of work before he leaves school. That may lead him to a ma-

---

* Reprinted from *The Minnesota Technolog,* December, 1945.

The observations and reflections of a non-engineering educator as originally presented in the *Bulletin* of the *Minnesota Federation of Engineering Societies.*

"I hold that it becomes no man to nurse despair,
But in the teeth of clenched antagonisms
To follow up the worthiest till he die."
—Tennyson

ter's degree; but whether it does or not, it is a sound investment that will later pay rich dividends. Let the other fellow get a year's start in a job; in ten years, other things being equal, the difference will be wiped out.

2. *If I were an engineer,* I would strive to be an educated man as well as a professional scientist. This means I would try to get as much as I could of the broad background of the liberalizing studies which now seem to be the special prerogative of graduates of the liberal arts colleges. One has to have some understanding of the world in which he lives; one must, in a greater or lesser degree, become a citizen of the universe. The engineer is now a factor, and an important factor, in the social equation. Society asks, nay demands, that he know what the score is. The progress of engineering through all recorded history has been co-ordinated and correlated with the demands of human society. Behind the present professional façade is a great and significant background of intertwined social relationships. Engineering has always been entangled, for good or evil, with social movements, with the operation of economic laws, with the vagaries of politics and with the theories and conclusions of philosophy. How can one understand things as they are if one is completely ignorant of things as they were? If this be admitted, then an imperative requirement for the prospective engineer is a summary course in the History of Western Civilization, with special emphasis on social and economic developments, art and philosophy. As time admits there should be added courses in sociology, economics, psychology and philosophy. If one has artistic tastes and aptitudes, they should be indulged; aesthetic development adds to the richness of living. I know several engineers who are competent musicians and, doubtless, there are many more who are devotees of the other fine arts. "But," someone asks, "how are you to do all these things and still have time for the rigorous curriculum in engineering?" One answer is the fifth year mentioned above. Another is that at this stage of the student's career only a rudimentary smattering of the subjects mentioned above is desirable or feasible. The rest must be obtained through constant reading and study throughout life. The main idea is to get in school enough of a taste of the subject to whet the appetite for more; thereafter that branch of learning may be pursued at intervals of leisure as an interest collateral with more specifically professional pursuits. The objective is to develop with maturity a mellow, well-read and reflective man, whose knowledge and interests are much wider than the technological field of his vocation. Unfortunately, engineers thus equipped are not as numerous as they should be. Thus their value as social agents and their dignity and prestige as members of a learned profession are unduly limited. By standing aside from public affairs engineers have found it difficult to obtain acceptance of the fact that they are truly professional men.

3. *If I were an engineer,* I would afford the luxury of a conscience. I would strive to feel in every undertaking a sense of social and moral responsibility and obligation. Today the engineer's absorption in technical training tends to divorce him from participation in humanity's yearnings and strivings for a nobler social order—an order wherein such virtues as truth, justice, magnanimity and righteousness shall flourish. The goal is conditions

favoring a rational life. H. M. Tomlinson, the English essayist, puts the whole matter graphically in the July, 1945, issue of the *Atlantic Monthly*. Speaking of the present catastrophe and social chaos, he says:

> Pride in man's control of nature overcame what sense of moral responsibility remained with us for the proper use of power. Revolutionary mechanical inventions were let loose into a society unaware of their inherent perils * * * We had not the least idea what should govern the purposes of men when they could dodge about the heavens. * * * Never before in history has man had such a store of knowledge and so little understanding. He has been satisfied with facts; he has cared little or nothing for the implications of facts and their relationship to a rational life. Immediate profit was all he wanted. The authority of religion, law, literature, and the arts went long ago, usurped by technology. * * * The present enterprises of men * * * have been directed heedless of a worthy tradition for guidance. They have had no background for reference at all. The only responsibility enterprise has acknowledged has been to some narrow personal advantage. Life itself has lost its importance.

Let the engineer note with care and with heart-searching those ominous words, "heedless of a worthy tradition for guidance," and, "no background for reference at all." Here in dynamic words is stated the gist of the argument for the inclusion of the social studies and the humanities in the curriculum of the engineer. And here philosophy, apparently alien to the engineer, comes in. Life has fundamental issues and bases which are beyond the scope and the purview of natural science. Man's relation to the universe and his destiny; his hopes, fears and aspirations; the problem of good and evil; the nature of learning and understanding; the definition of a good life—these are all matters that concern all men, regardless of their vocations. Let engineers of today take heed of the words of Vitruvius, a Roman architect and engineer of the first century B. C. He wrote the earliest known treatise on architecture, and in it he made philosophy a prerequisite for the architect. It would make him "high-minded, urbane, just, loyal, and without greed; for no true work can be done without good faith and clean hands."

4. *If I were an engineer,* I would make it my prime business to learn to write and speak English well. Somehow the public justly or unjustly, tends to judge a man's quality by his speech or by his writing. This is especially true of first impressions. That is why it is a matter to be deplored, by educators and the general public alike, that so few college graduates write with ease, with accuracy and with clearness. This defect is by no means unavoidable; a relatively small amount of painstaking will remedy it. This we know because some engineers write and speak well and yet are products of the same curricula as turned out their less accomplished brethren. It is a matter of realizing the importance of this ability and then of assiduous application to the acquisition thereof. It has been done and it can be done by anyone capable of getting through an engineering school.

When I speak of writing well, I do not mean the ability to produce ornate paragraphs and purple passages. Leave that to literary artists such as Macaulay or Gibbon. I am speaking of straightforward, simple prose composed of sentences that track and that have organic unity. Occasional lapses

in spelling are common enough with all of us and can be corrected easily by a competent stenographer or proof-reader. But solecisms, involved and intricate arrangements of words, and a multiplicity of dangling phrases and subordinate clauses—these are the despair of every editor's heart and the cause of acute discomfort to the reader. The engineer does not need long, ponderous paragraphs full of intermeshing cogwheels of phrases and interlocking directorates of clauses. He writes, not to induce aesthetic pleasure, but rather to convey his meaning, easily and clearly. Therefore he should write short sentences, with the words carefully chosen and carefully arranged. Is this too much to ask of an engineer who, in designing machinery, will work patiently for hours to secure a tolerance of a thousandth of an inch? Much of the difficulty may be ascribed to sheer carelessness or indfference. Let it not be forgotten that easy writing often makes hard reading and that easy reading often is the result of hard writing. The thing to avoid is the slovenly, hazy sentence, lacking the sharp outlines of good workmanship. It is better to kill the squirrel with a rifle bullet in the eye than to shoot all over the tree with a shotgun.

Much of what I have just observed about written matter will apply also to speech. It should be noted again that I am not offering advice about Fourth of July orations or commencement addresses. What the engineer will most need in his business is the ability to get his ideas across to small groups of people in such a way that, first of all, he will be heard and understood; and, second, that his audience will be impressed, convinced and moved to appropriate action. The engineer, in the pursuit of his profession, will find it necessary from time to time to address committees, boards of directors, school boards or groups of legislators. He will do this for the purpose of selling his hearers his ideas or plans about a proposed project or undertaking— and, incidentally, for the purpose of selling himself as the man to put these plans into effect. He will also occasionally feel impelled to rise at meetings of his fellow professionals to advocate or oppose certain ideas or policies under discussion. In these situations there are always two factors present: what he has to say, and how he says it. The preparation of what he has to say has already been covered in the advice about writing. But here we must emphasize again the value of short sentences; the spoken word tends to vanish and hearers do not easily carry in mind long sentences. Of course there should be enough variation so that monotony does not ensue. The style should be simple, friendly, conversational. The audience should be impressed by the speaker's candor, sincerity and earnestness. But his argument should have both persuasiveness and cogency. To power and drive should be added coherence: that is, the arguments should have continuity and a logical sequence.

The mechanics of speaking should not be overlooked. No speech is effective that is not heard. The speaker should cultivate a clear, resonant voice; he should not mumble or gargle his words. He should pitch his voice at the farthest listener; then those nearer will be sure to hear. Above all, he should learn to open his mouth and project his words with clear articulation. During the past year I have heard more than one admirable argument ruined by faulty delivery. Let the aspiring engineer attain these

worthy ends by assiduous practice. Let him speak extemporaneously on every occasion when he has something to say. Thus he will learn to think on his feet, to marshall his thoughts in orderly sequence and to find appropriate words with which to express his ideas. How important ability and skill in the sphere of expression are to the professional status of the engineer may be judged from the following editorial in the *Engineering News-Record* of May 31, 1945:

Recently at a Congressional hearing in Washington a capable civil engineer holding a responsible position was criticized by the Senator serving as chairman because of the engineer's failure to speak with sufficient vigor to permit all of the small group present to hear. Unfortunately this is no isolated example. It is the rule rather than the exception when engineers appear in public. That fact needs to be recognized by those who complain so bitterly over public apathy toward engineers as a group. Their program directed toward public recognition must begin within the profession itself. Until engineers learn to look upon their own contributions as of such importance as to call for forceful and convincing presentation they cannot expect the public to hold their profession in high esteem.

5. *If I were an engineer,* I would always consider myself and conduct myself as a professional man, a member of a learned profession. In that capacity I would carry out my professional obligations and responsibilities with dignity, with integrity and with self-respect, mindful at all times of that code of ethics and of professional conduct which has been built up by many generations of honorable men. I would be ever mindful of that rich heritage of principles, procedures, scientific data, formulae and mechanical devices that I have derived from my intellectual ancestors and which now enable me to make my contribution to the service of humanity. As a return for this heritage I would feel myself bound to make some contribution to the accumulated store, so that my successors could start from a higher level. To that end I would join the society of my special branch of engineering and work zealously with my fellows for increased knowledge, more efficient techniques and processes, and a general elevation of standards and qualifications. In addition, I would feel it my duty to join and to support some over-all organization that could speak with authority and with one voice for my profession as a whole. Through such an organization, relations with the public, with legislative bodies and with labor unions could be unified and the conflicting interests of all parties could be reconciled.

6. *If I were an engineer,* I would constantly bear in mind the danger of becoming a materialist and I would take effective measures to counteract that tendency. Engineers deal constantly with mathematics, with scientific principles and laws, and with the properties of materials. Their achievements are always produced in terms of tangibles. Hence arises the tendency to put their faith, their trust, their confidence, in *things*—visible, tangible, useful things. There is mortal peril in such a state of mind. There is little doubt that the pagan glory and exultation in power, wealth, machinery, production, construction, which has seized masses of people during the past generation or two, have been at least partially responsible for the grievous plight in which the world now finds itself. This whole trend should be resisted.

It is time that engineers as well as others fall back upon some ancient truths that have not lost their validity. My point may be illustrated by two quotations from a well-known ancient Book of wisdom. One is, "Man shall not live by bread alone." The other is, "For the things which are seen are temporal; but the things which are not seen are eternal." Here we have two scales of value: the structures which man erects and the possessions with which he surrounds himself; and the attributes of the mind and the spirit which ennoble man and raise him above the level of the brute.

It is well for the power-conscious engineer to realize as a chastening and humbling thought that he has brought no power into the world. All the power we now have was always here. The engineer has merely discovered and tapped the sources of power and then devised machinery to utilize it. Adam had the power of falling water if he had known how to use it. The first man that boiled a pot of water had the steam engine in embryo. All the coal and the oil and the gas were there from the beginning; and electricity was everywhere, as it is today. No new power has come into the earth since the beginning; but doubtless there is more to be discovered and utilized. Let man therefore not too highly exalt himself, but in all humility and reverence turn his God-given talents to the furtherance of that "far-off divine event to which the whole creation moves."

Report of the First Annual Industrial-Agricultural Week at Kansas State College

By A. L. PUGSLEY

Chairman, Industrial-Agricultural Week Committee and Assistant Director of the Engineering Experiment Station

The Industrial-Agricultural Week Conference held November 8, 9 and 10, 1945 at Kansas State College represents a new type of meeting for Kansas Industry and Kansas Agriculture. Comments of persons from other states indicate that it might be unique elsewhere also.

Even at the time of accepting the Presidency of Kansas State College two years ago, Milton S. Eisenhower held the conviction, from which this conference grew, that the welfare of the nation depends to a large extent upon the joint prosperity of its industry and agriculture. The interdependence of industry and agriculture is now generally accepted by most people, but for it to achieve balance, the food producing and raw materials producing states of the midwest region require increased industrialization in the form of thousands of small industries, many of which will process agricultural materials, and all of which will promote agricultural and industrial prosperity by furnishing employment.

Kansas is in a particularly favored spot for such development. No longer throttled by the discriminating freight rate structure which for years has overbalanced its natural strategic location in the center of the United States, and being blessed with well distributed and varied mineral and power resources, abundant industrial water, and trouble-free labor which possesses industrial know-how gained in the crucible of war experience, Kansas need be shy no longer.

Development and achievement of a sound industrial-agricultural expansion requires that all available facilities for research be brought to focus upon the problems of industry and agriculture, and particularly, that research facilities be made available to those smaller businesses and industries which cannot afford to develop efficient research facilities of their own. For these reasons the conference was called.

The three days of the conference were divided to treat a different section of the overall problem as follows: "Research as an Aid to Industrial Development" on the first day, "Opportunities for Industrial Development" on the second day, and "Factors Affecting Industrial Development" on the third day.

In the opening address of the conference entitled "What the Conference is about," President Milton S. Eisenhower reviewed the impact of present day economic forces upon the farmer, whose success is no longer determined only by personal efficiency of production and weather, but also now by national high

economic activity, including optimum employment at reasonable wages, and an abundant world trade. The failure of this country to export from 30 to 50 per cent of certain agricultural commodities such as cotton and wheat results in surpluses which cause serious economic dislocations in the domestic market. Peculiarly enough, the farmer can produce well and face bankruptcy at the same time. The parity or above parity prices of the war years have been in great contrast to the depression years, yet agricultural production during the war exceeded prewar production by 35 per cent. Yet there have been no surpluses, and 88 per cent of agricultural production has been consumed by our own people, because they have had a greater buying power. It is therefore imperative for agriculture to have a prosperous industry, but it is equally imperative for industry to have a prosperous agriculture. Kansas cannot have a prosperous agriculture, however, as long as the population of the state declines as it has during the past 20 years. Kansas must therefore absorb the migrating portion of her population in small industries within her own borders. To unite in the development of these industries Kansas must use the research laboratories of this area, which include those of this institution, the University of Kansas, the University of Wichita, and the Midwest Research Institute.

Following President Eisenhower's opening remarks, Victor Conquest, Director of Chemical Research and Development for Armour and Company, Chicago, Illinois, spoke on "Do All Industries Need Research?" Mr. Conquest elaborated upon his opening statement of "The answer is an unqualified 'Yes,'" to explain various types of research and the planning of research programs, but emphasized that whatever kind of research contemplated, it must be good, and not be established as a year to year affair, but be supported for a period of years. The sponsor likewise must have the will and ability to take full advantage of the results of the program. So important is fundamental research activity that it represents the vitality of all progress and deserves the support of industrial executives and the public alike. Four tools were listed for securing uninterrupted fundamental research:

1. The insistence of taxpayers that a fair share of taxes allocated to education is marked for research at state educational institutions.

2. The insistence of taxpayers that the Congress support fundamental researches.

3. The giving of grants by business men and industrial concerns both large and small, for fundamental investigations.

4. The establishment and support of Research Foundations.

Of importance, also, are industry associations supporting research for the common good of the industry. Explanations followed on the operation of a research organization, the research team, "side issues," market research, process development and research costs.

Continuing the research picture Harold Vagtborg, President of the Midwest Research Institute of Kansas City, Missouri, discussed "Research Facilities of the Midwest Area." Whereas products of the area's educational institutions, like those of her fields, mines, and wells, have formerly been sent east, "extractive" industries in the area are now less popular, and industrial expansion is being stressed, as for example the rather unorthodox

but sound step of establishing state appropriations specifically for research and development, all in the interest of unborn industries as well as local industries which will expand. One of the prime research facilities of the area is its sincerity in wanting to balance its economy, and its willingness to do the job.

President Emeritus Farrell of Kansas State College concluded the first morning's meeting with a description of "The Policies and Organization of Research at Kansas State College." Under the statutes embodying the College's charter research at this institution must be in the public interest and predominantly of an industrial (including agricultural) nature. Both pure and applied research are included in the interpretations made of this activity. The policies adopted recognize the time requirements of research, and involve increasing cooperation with individuals, and public and private bodies. Although freedom of research is emphasized, this does not mean irresponsibility. For patents, the Kansas State College Research Foundation, a non-profit organization operating under regulations prescribed by the Board of Regents, stimulates and supports research at the College, safeguards the public interest, and aids in placing patented inventions and discoveries into beneficial use. In concluding, Dr. Farrell described the three branches into which Research is divided at Kansas State College, (1) The Agricultural Experiment Station, (2) The Engineering Experiment Station, and (3) Informal Research by almost all College Departments.

The afternoon meeting of the first day presented the research work of the College. When the committee was formulating plans for this part of the program there was considerable discussion trying to determine the most effective manner to inform the group of the nature, scope, type, and effectiveness of College research and facilities. The committee never did achieve unanimity on the subject. The method adopted, however, scheduled Dean R. A. Seaton, Director of the Engineering Experiment Station, and Dean L. E. Call, Director of the Agricultural Experiment Station, for 15 minute summaries of their experiment stations, following which 12 selected research projects were presented in 7½ minute intervals by the department staff members most intimately associated with the work. The 12 projects were as follows:

1. Dehydration of Agricultural Products by Ralph Conrad, Department of Chemistry; 2. Electronics for Industrial Use by R. G. Kloeffler, Department of Electrical Engineering; 3. Agricultural Machinery by F. C. Fenton, Department of Agricultural Engineering; 4, Breeding Crop Plants for Industrial Use by R. I. Throckmorton, Department of Agronomy; 5. Electrolytic Polishing of Metals by A. E. Hostetter, Department of Shop Practice; 6. Industrial Utilization of Dairy Products by F. W. Atkeson, Department of Dairy Husbandry; 7. Improving Concrete by C. H. Scholer, Department of Applied Mechanics; 8. Research in the Milling Industry by J. A. Shellenberger, Department of Milling Industry; 9. Industrial Utilization of the Sorghum Grains by H. H. King, Department of Chemistry; 10. Colloidal Fuels by J. W. Greene, Department of Chemical Engineering; 11. Products for Cold Storage Lockers by G. A. Filinger, Department of Horticulture; 12 Utilization of Industrial By-products

by Livestock by A. D. Weber, Department of Animal Husbandry.

For the balance of the afternoon the Departments of the two Experiment Stations invited the guests of the conference to visit their offices and laboratories for inspection of research facilities and discussion of research problems. Many guests used this as an opportunity to learn more about the projects reported on, others were interested in ascertaining whether the College had facilities to undertake work for them. For guests who wished a more complete survey of the College facilities, guides conducted a tour. The enthusiasm with which this afternoon program was received was startling to the Committee who had feared that the guests would feel they were being propagandized. The words of one visitor, however, served to express the sentiments of most when he said, "Why haven't you told us about these things?" The Committee learned one important thing at this point, which was that to tell the story of research for an institution effectively you must reach individuals in a direct and a personal way. All of these things had been publicized through the press and other means but had not found their mark through these mediums.

Concluding the Research portion of the program at a banquet the evening of the first day, and initiating the section on Opportunities for Industrial Development, which would begin the second day, A. A. Potter, Acting President and Dean of Engineering at Purdue University inspired his entire audience with a splendid address entitled "Research and Invention as Doors to Opportunity."

In it he emphasized that American industry must make maximum use of research as an effective substitute for destructive economic tactics which have been practiced in highly competitive fields. American industry must aid in establishing new frontiers of progress by constantly creating something new. Even abundant natural resources are of no value in raising standards of living unless a nation's people have character, industry, idealism, and creative ability to utilize those natural resources for the benefit of humanity. In the past century American men of genius have been responsible for more than one-half of the major inventions in fields of communication, transportation, agriculture, industry, and power generation and transmission.

Dean Potter contrasted effectively the effect on industry of governments under totalitarian states to those of this country, and expounded upon the patent structure which has contributed significantly to American development. Only one in six inventions has as its primary purpose the saving of labor; the other five-sixths of all inventions create employment, increase wages, increase wealth, decrease drudgery, improve working conditions, improve quality of product, and reduce the cost of goods. Contributing to America's progress also is the willingness to discard a satisfactory present in order to create a better future. "Rapid obsolescence," said Dean Potter, "engenders invention."

To our republican form of government, which idealizes the rights of the individual above those of the state, belongs the credit for making possible the epoch making inventiveness of the American people by providing the individual's freedom, and in the preservation of that freedom lies the security of our future. Education alone, no matter how liberal or scientific, will not necessarily make for the best and

noblest of human values, as we have seen in the action of European countries.

In opening the second morning's session on "Opportunities for Industrial Development," chairman Harry Darby, manufacturer of Kansas City, Kansas, pointed out specifically how important to development of peacetime Kansas industry is the know-how which has been acquired by Kansas workers and managers during the war when Kansas surprised the nation with unprecedented production of precision war materials. During the morning meeting of three and a half hours, eight speakers described and analyzed industrial opportunities in Kansas in selected fields:

1. "Agricultural Machinery" was discussed by Harold Reed, Factory Manager of Davis Westholt, Inc. of Wichita, Kansas. This company is converting from wartime manufacture of aircraft parts to peacetime manufacture of farm machinery built on aircraft manufacture and assembly line techniques. Objectives of the company are to make equipment having greater adaptability to more farm jobs by using attachments and interchangeable parts. Mr. Reed predicts lower investment costs to the farmer, more machines which are one-man operated, and revolutionary advances in farm machinery manufacturing processes. In his opinion Kansas, being in the market area, and having power, labor, and abundant raw materials, can lead in the field.

2. "Petroleum and Gas in the Heat and Energy Field," by John C. Day, Secretary of the Western Petroleum Refiners Association, Tulsa, Oklahoma, reviewed the development of the oil industry of the nation and of Kansas in particular. Few people realize that Kansas produces 272,800 barrels of oil daily from 26,250 producing wells, or that Kansas ranks third among the states in proved natural gas reserves. Mr. Day encouraged Kansas industry to devote more attention to research, to use the educational institutions of the state, to employ their graduates rather than letting them go elsewhere, and to cooperate in the development of the industry. Although the largest peace time user of petroleum was the automobile, petroleum is constantly becoming more useful to the chemical industry as a raw material.

3. To complete the power picture, Kenneth A. Spencer, President of the Pittsburg Midway Coal Mining Co. of Pittsburg, Kansas, spoke on "Problems and Potentialities in the Field of Coal Production and Distribution." Mr. Spencer divided his talk into four simple headings: (1) Problems of Production, (2) Problems of Distribution, (3) Potentialities of Production, and (4) Potentialities of Distribution, all as applied to coal.

The potentialities of an industry which furnishes power to generate 60 per cent of all electric energy in this nation, furnishes heat for ¾ of all our homes, furnishes 85 per cent of all base material for plastics, is essential in making 100 per cent of the steel, and supplies the basis for chemical products, are too big to be summarized quickly. Mr. Spencer provided facts and figures which were startling to the uninitiated. Of particular interest was the Kansas production figure of 3.6 million tons of coal by strip mining alone in 1944. Most Kansas coal is consumed within the state. Equally revealing was the graphic picture of how coal is used by industry as a base for synthetic products.

4. W. S. Small, President of the

W. S. Small Company, Inc. at Neodesha, Kansas, erected the first alfalfa dehydration plant west of the Mississippi. In speaking on "Dehydrated Alfalfa" Mr. Small traced the story of alfalfa and alfalfa dehydration from early times to the present. Artificial drying of alfalfa is now a sizable industry in Kansas, and produces a product superior to natural dried alfalfa in carotene content which the body converts into vitamin A. Mr. Small gave a most comprehensive picture of the methods used in successful operation of such plants, together with the uses and markets for the product.

5. Discussing "Stone, Clay and Ceramics," Charles S. Cook, President of Cook and Cook at Concordia, Kansas, described the history of establishing the new brick and tile plant in that city. Briefly the story is one of discovery and survey of the field by the State Geological Survey, analysis and tests of the clays available, development of interest by the town, planning for the new post war industry, including analysis of facilities, property, power, gas, transportation and market, and the formulation and financing of Cloud Ceramics Co. Their extensive, modern, gas-fired plant will begin operation about January, 1946. Contrasting to Mr. Reed's opening address of this morning session relating to conversion of an established plant to a new product, here was an industry starting from scratch.

6. Robert M. Owthwaite, Vice President of the John Morrell and Co., and General Manager of the Topeka, Kansas Plant, reviewed the opportunities and problems of "The Meat Processing Industry." Production, shipping and marketing of livestock alone require the attention of the most substantial portion of our agricultural population, and together with the processing and distributing of livestock produce by meat packers, wholesalers, and retailers, account for the employment of about one-sixth of the workers in this country, a striking example of "Industrial Wedlock" between industry and agriculture. Because 75 cents out of every dollar received by the packers goes to the farmer, livestock represents the most important single source of cash income to the American Farmer.

Although the search for new products, methods and markets is motivated by desire for greater profits, a more important result is that profitable ideas are soon adopted by all within the industry and what were last year's profits to the innovator provide this year's net gain to the supplier of raw material or to the ultimate consumer. By-products utilization permits astonishing reductions in consumer prices of the major product. Only 70 per cent of the hog is sold as pork and lard, 55 per cent of the steer is sold as beef, and 47 per cent of the lamb is edible meat. Mr. Owthwaite analyzed in detail the market history of livestock in Kansas and showed the place of livestock production to a balanced agriculture for Kansas. He deplored the wasteful system we now employ of shipping long distances for processing raw material in different sections of the country when they could be processed equally well at home. Such a system in his opinion represents economic suicide.

7. Speaking on "Feed Milling," Vernon Alford of Shellabargers, Inc., Salina, Kansas, first reviewed the history of feed milling in Kansas and related that to the milling industry as a whole. Since mixed feeds are balanced feeds containing predetermined quantities of digestible nutrients, they utilize effectively as highly prized ingredi-

ents former wastes such as mill feed, molasses, and cotton seed, and are the foundation of better than a billion-dollar industry. The proper use of mixed feeds for specific purposes permits elimination of guesswork and guarantees quicker production of eggs, milk, meat, or wool at the lowest possible costs.

8. L. C. Heckert, Director of Research, The Military Chemical Works, Inc., Pittsburg, Kansas, closed the morning meeting with "Some Observations on the Development of Chemical Industry in Kansas." Mr. Heckert made a strong plea for conversion of war chemical plants to commercial production of fertilizers. The fact that the second world war has been characterized by marked development of chemical industry in the Middle-west, particularly in the gas and oil regions, should indicate the opportunity in these same regions for commercial enterprises along similar lines, particularly for plants producing basic chemicals. In Mr. Heckert's opinion, however, the development will have to be done by Kansans, for those outside the state are primarily interested in continuing to exploit its raw materials alone.

After the luncheon period the group assembled to hear R. B. Wittenberg, Manager of the Potash Chemicals Department of the International Minerals and Chemicals Corporation, Chicago, Illinois, discuss "Estimating Production and Distribution Costs for New Industries." Mr. Wittenberg's address was especially designed to assist in avoiding pitfalls commonly encountered in estimating production and distribution costs, important particularly because it usually involves the ultimate investment of large sums of money—usually belonging to other people. Careful study of Mr. Wittenberg's paper would repay any engineer or other person seeking to establish an industry. Treated in detail are problems of Market Study, The Flow Diagram, Plant Cost Estimates, Organization and Labor Charts, Production Cost Estimates, Raw Materials, Direct and Indirect Labor, Variable Costs, Fixed Burdens, Gross Revenue, Total Capital Requirements, Profits, and Taxes.

Following Mr. Wittenberg's address the Conference adjourned to reconvene in the College Auditorium to hear the Honorable Clinton P. Anderson, United States Secretary of Agriculture, Washington, D. C. speak on "Agriculture, Industry, and the Future of Farmers." In speaking of the conference, Secretary Anderson said, "It is a great pleasure for me to take part in this conference because I believe so firmly in its objectives. There ought to be more work of this kind.—Interdependence of agriculture and industry is a fact we must all recognize and understand if we are to be successful in establishing the basis for permanent prosperity—a two way flow of buying power and goods between agriculture and industry." Secretary Anderson reviewed the causes and effects of the depression years, and pointed out that cash receipts from farm marketings and income of industrial workers are closely interdependent.

"Agriculture has its broad objectives for the postwar period," continued Secretary Anderson. "They are summarized by (1) Production of plenty of food at prices fair to consumers to establish a truly high level of nutrition in the United States, (2) Greatly increased efficiency in production, processing and marketing of farm products, (3) Conservation of our soil, water supply, and forests, and (4) An ex-

panding free-moving trade with other nations.

"Agriculture would like to see industry and labor set goals equally high, perhaps as follows: (1) Full scale production of foods and services at fair prices, (2) Increased efficiency in industrial production, processing and distribution to lower the costs of goods and widen the market for them, (3) Payment of wages as high as commensurate with a fair return to capital and management, and (4) Development, with agriculture, of an expanding unobstructed world trade."

The balance of this Secretary's address elaborated on these points.

At five that afternoon guests of the conference attended a reception and tea at the President's Home in honor of Secretary Anderson and Governor Schoeppel. The conference reconvened with a banquet following which the Honorable Andrew F. Schoeppel, Governor of the State of Kansas, spoke on "The New Freight Rate Structure and Kansas Industry." Governor Schoeppel is intimately familiar with this subject, for his duties as Chairman of the State Corporation Commission prior to his service as governor required vigorous participation in the activities of the State in dealing with it. Governor Schoeppel reviewed the discriminating freight structure which favored exploitation of raw materials of the states west of the Mississippi River and which prohibited industrial and processing development in that area. The discrimination was two fold, in classification schedule, and in class rate level. The fact that the Interstate Commerce Commission instituted proceedings requiring 5 years of hearings to study the schedules and rates, and that the discriminations now are being removed effective about the first of January 1946, proves the validity of the claims made. Kansas can look forward to an industrial development thriving in equal competition with other sections of the country.

The last day of the conference was devoted to "Factors Affecting Industrial Development." Mr. William E. Long, Secretary-Director of the Kansas Industrial Development Commission, served as Chairman of this session. In introducing the subject Mr. Long demonstrated by a quick survey of a number of products being manufactured in Kansas that the constructive thinking, ingenuity, and ideas are even more valuable for industrial development than are natural physical resources. It was his expressed belief that Kansas possesses all.

The six topics of the morning discussion follow:

1. "Is the Economic Climate Going to Be Favorable to Industry?" by W. E. Grimes, Head of the Department of Economics and Sociology, Kansas State College, provided a comprehensive analysis and digest of federal, state and local tax rates; existing and probable corporation laws in Kansas; venture capital; markets and transportation; management ability and labor; price policy; and government control. Dr. Grimes concluded that economic conditions prevailing and probable in Kansas are favorable for establishment and healthy growth of many small industries here.

2. "Economic Availabilty of Electric Power for Industry in Kansas," by R. W. McClure, President of the Kansas Electric Power Company, Lawrence, Kansas, revealed that one of the principal factors permitting location of so many war plants, and Army and Navy Bases, to Kansas was the availability of dependable electric power having a sub-

stantial reserve capacity. About one-fourth of Kansas Power Plant capacity was used in serving war loads. This war load is now released and is available for reestablishment of peace time industries and new industries. Seldom if ever, is the cost of power the determining factor in bringing industry to a given locality. Of total cost of all manufactured products, only 1.44 per cent is spent for electrical energy. Power factors which are considered more important than cost are dependability and adequacy. Very great savings are enjoyed by fuel burning generators of power over hydroelectric plants, together with their greater dependability factor as illustrated by the T.V.A. power shortage of 1941.

3. "Water Needs for Industrial Purposes" was presented by Geo. S. Knapp, Chief Engineer of the Division of Water Resources, Kansas State Board of Agriculture, Topeka, Kansas. Water is one of the most basic of the natural resources necessary to man's economic development, as well as to the industrial development of any area. For instance, the recently established Goodyear rubber and tire plant which requires 6 million gallons per day at a temperature of not more than 57° F. was located near Topeka only after it was ascertained that a supply of ground water meeting these requirements could be obtained there.

Kansas has had abundant water and rainfall during all of the war years. The drouths of the thirties in the mid-west became the drouths of the forties in states east of the Mississippi. Mr. Knapp then reviewed in detail the present work and proposed plans of many agencies, state and federal, which are concerned with water supply, flood control, navigation, irrigation, waste disposal and power.

4. "Kansas Minerals for Industrial Use," by John C. Frye, Assistant Kansas State Geologist, Lawrence, Kansas, presented the picture of mineral resources of Kansas which for the past 13 years has constantly been among the top 10 mineral producing states of the nation. The minerals and underground resources of Kansas are diversified in number and in location, and include quantity deposits of zinc, salt, petroleum, natural gas, coal, volcanic ash, sand and gravel, gypsum, stone, clay, lead, bauxite, bentonite, chalk, and diatomaceous marl. A summary of the industrial uses to which these products have been and may be placed was also made by Mr. Frye.

5. Harold Howe, Dean of the Graduate School, Kansas State College, next discussed "The Effect of the Tax Structure on Industrial Development." Dr. Howe prefaced his remarks by directing attention to the fact that any specific industrial development is confronted by Local, State, and Federal tax structures with the last occupying the most prominent position recently.

From analysis of a proposed post-war Federal Budget of 22.4 billion dollars, calculated from an estimated national income of 125 billion dollars, Dr. Howe concludes that the high taxation rates necessary to meet post-war expenditures will not fall appreciably below the rates established during the fiscal year 1945 when the government collected taxes of 46.5 billion on a far greater national income. To this another 10 billion dollars annually must be added for local and state expenditures. Greater equity in taxation, the most intricate of all tax problems, and the one calling for the most objective treatment, is one of the most needed aspects of the taxation problem.

6. In speaking on "Democracy Needs Small Business," Lou E. Holland, President of the Holland Engraving Company, Kansas City, Missouri, said, "This is a subject close to my heart, for I am a Small Business Man. Our prosperous communities are made up largely of Small Business—for Small Business outnumbers Big Business about 1500 to 1." Under 2,000 concerns in the United States have more than 1,000 employees, and 1.7 million concerns, excluding agriculture, employ not over 100 employees. There are about 1.3 million individual enterprises with no employees. During the war about 50 thousand small businesses were lost which now should be re-established. Encouragement also should be given to others to engage in business for themselves. Never in our history has small business had such opportunities as today, but unless risk capital or banks can see prospects for better returns than taxes, wage scales, and government controls now permit, many of these opportunities will pass by undeveloped. Every big business has grown from small business. Small business and new enterprise furnish one of the nation's greatest laboratories for new ideas and new products. "In my opinion," concluded Mr. Holland, "a community is far better off with 100 concerns giving employment to 10 people each than one concern giving employment to 1,000. If we are to have a Democracy, we must have Small Business."

In concluding the program, President Eisenhower announced that a second Industrial-Agricultural Week would be held at Kansas State College a year hence. Expressions from the conferees during and at the close of the conference, and letters received from them after the conference, indicated that the conference had met a need and that it had been highly successful.

It was a matter of regret that physical facilities of the College and town required that attendance of the Conference be limited to 125 invited Industrial and Agricultural leaders. On the other hand the informal atmosphere produced by a meeting of this size contributed to the success of the gathering. Luncheons and dinners were provided on the campus in the same building in which meetings were held. The reception at the President's Home, Friday afternoon, and the Home Coming Football game Saturday afternoon added social events which broke satisfactorily the business sessions. The committee responsible for formulation of plans for the Conference and their execution was composed of two members of the School of Arts and Science's Department of Chemistry, H. H. King, and R. L. Conrad, one member of the School of Agriculture's Department of Dairy Husbandry, F. W. Atkeson, and two members of the School of Engineering, C. H. Scholer of the Department of Applied Mechanics and A. L. Pugsley, Assistant Director of the Engineering Experiment Station who acted as chairman.

Complete proceedings of the Conference will be available free in single copies upon request to the Engineering Experiment Station. A charge is made for quantity orders. The proceedings will merit the careful reading by engineers wishing to obtain a more complete picture than could be presented in this very superficial summary.

An Experiment in Course Administration

By PAUL H. BLACK

Associate Professor of Machine Design, Cornell University

A course in "Advanced Machine Design" has been given at Cornell University for the past several years with popularity among the participating students and with expressions of appreciation by graduates. The course has been required of all students specializing in mechanical design and elective for other qualified students. It is felt that some members of S.P.E.E. may be interested in this course, particularly from the standpoint of its organization.

The sections have generally been limited to 12 or 15 students and meet for one hour three times a week throughout a 16-week term. The meetings are termed lecture-discussion periods in which the instructor presents the subjects by informal lectures and encourages discussion from the floor at all times.

The content of the course was originally laid out after discussions with several men from industrial and educational institutions, and stands at present as follows:

I. Applied Mechanics:
   1. Stress and strain in a bar due to its own weight.
   2. Propagation of stress in elastic materials.
      Reflected and transmitted waves.

II. Stress Concentration:
   3. Causes.
   4. Corrective methods.

III. Experimental Stress Analysis:
   5. Brittle-material method.
      Photoelastic method.
      Brittle coatings.
      Strain gages.

IV. Plasticity and Creep:
   6. Idealized elastic and plastic states.
   7. Plastic flow in tension and compression.
      Plastic flow in torsion.
      Membrane analogy (Prandtl), and sand-heap analogy (Nadai).
   8. Creep and creep-testing equipment.
      Creep curves and creep-design curves.

V. Fatigue in Metals:
   9. Endurance limit. Effects of stress, temperature and environment.
   10. Corrosion and embrittlement.
      Mechanical pitting and fretting corrosion.
   11. Fatigue failure under combined stresses.

VI. Surface Finish, Friction and Wear:
   12. Preparation and measurement of surfaces.

13. Effects of finishing processes.
14. Mechanisms of wear.
15. Friction.
16. Types of wear.

VII. Lubrication:
17. Dry friction, oily friction, fluid friction. Load-carrying oil film.
18. Hydrodynamic theory of lubrication.
19. Characteristic ZN/p curves.

VIII. Vibration and Vibration Control:
20. Free and forced vibration, without and with damping.
21. Critical speeds of shafts.
22. Torsional vibration dampers.
23. Vibration measuring instruments.
24. Vibration control.

IX. Recent Developments.

X. Presentation of Technical Papers.

On reading the outline, one may feel that the course covers more ground than can be treated adequately in the allotted time. The objective of the course must be considered here, i.e., applications and recent developments are to be stressed and a minimum of time is to be spent on fundamental principles with which the student is already familiar.

The subject of vibration, for instance, is treated by a brief review of necessary principles, and the emphasis is then placed on such items as the construction, characteristics, and selection of vibration-absorbing mountings with definite applications and typical problems. Some of the problems are worked in class, followed by more comprehensive ones assigned for outside work. An extensive bibliography is furnished each student at the beginning of the course.

A feature of the course is the preparation and presentation of a technical paper. Each student is required early in the term to indicate a subject of his own choice on which he will prepare the technical paper during the term and which is to be presented before the class. The last meetings of the class are reserved for the presentations of the papers for which each student has a full class period for his paper. A schedule is prepared and a formal program is distributed. These meetings are conducted in a manner similar to the technical sessions of the engineering societies, i.e., introduction of the speaker, presentation of the paper including use of slides if appropriate, and a discussion. The discussions have proved to be one of the most interesting parts of the course. Visitors are welcome and students themselves participate as chairmen, projection operators, etc. It has been the custom to hold the last meeting of the term as an evening meeting preceded by a dinner.

The choice of subjects for the papers has been limited only to technical subjects "in which mechanical designers may be interested." Following is a list of subjects on a typical program:

1. Jet Propulsion.
2. Aircraft Superchargers.
3. The Turbine Locomotive.
4. The Cooling of Air-Cooled Aircraft Engines.
5. Microradiography.
6. The Treating of Structural Woods.
7. Boat Propellers.
8. The Engineering Properties of Plastics.
9. Electric Strain Gages.

10. Optical Gages.
11. The Fluid Coupling.
12. The Gyroscope; Theory.
13. The Gyroscope; Applications.

There are two one-hour examinations given during the term, and the technical paper is graded giving weight to preparation, presentation, and handling of the discussion.

This course has been given ten time during the past eight years. It is believed that the students who have take the course have benefited from th course work and the technical paper and that the inspiration of develop ments has served as a stepping ston from scholastic training to industri accomplishments.

A National Spokesman for Engineers*

By A. B. STICKNEY

Past President and Chairman, Committee on Relations with Other Organizations, American Society of Refrigerating Engineers

There are upwards of 200,000 engineers in this country sufficiently interested in engineering as a profession to have joined a society, but not over 10 per cent of them belong to any one society. There is a widely-felt need of an over-all organization of all the societies to act as spokesman for all engineers on matters of common concern. On a local basis over 100,000 engineers in 35 metropolitan areas have organized themselves into Local Councils, and are doing an effective job of intersocietal cooperation within their sphere of activity. In the last few years much has been said and written about a similar organization on a national scale. Everybody wants it—everybody is talking about it— it's in the air—it's coming—it's inevitable. While it is no longer necessary to talk about why or whether there should be such an organization, there is no such unanimity about what it should be like. This paper outlines a proposed organization by answering four questions—who, how, what and who will pay for it.

First, *who?* It should be built on the foundation that the American Standards Association has so effectively employed, that anyone having a legitimate interest has an inherent right to participate. There are five types of organization which have that legitimate interest. They are:

1. The so-called Founder Societies—Civil, Electrical, Mechanical, Mining & Metallurgical, and, included in recent years, Chemical Engineers. These Societies have large memberships, and each embraces a whole field of engineering. Together they have perhaps 40 per cent of the engineers of the country on their rolls.

2. The specialized National Societies. The Agricultural, Automotive, Heating & Ventilating, Illuminating, Radio, Refrigerating, Tool and a host of other Engineers, all have their own Societies. While some of the members of these Societies are also members of Founder Societies, there is a general disinclination to belong to more than one Society, and a great many of them have dropped their Founder Society memberships because only an occasional paper or article was of significance to them, whereas in their specialized society a large part of the papers and other activities are of interest, and the closer contacts in the smaller groups are more stimulating. Beyond that, these societies generally have an associate grade of membership for the men who would not be eligible under the stricter rules of the Founder Societies, but who none-the-less practice engineering, and these men must be included in any organization undertaking to speak for engineers as a whole.

*This article is being printed in the April issue of magazines of other societies and is for the information of our members.

Collectively, these specialized societies have a larger membership than the Founder Societies.

3. Local specialized groups, similar to the specialized national societies but not organized on a national scale. There are a number of such organizations in the various Local Councils, and they undoubtedly exist in considerable numbers in all the larger metropolitan areas.

4. The Local Councils, which are composed of the Local Sections of National Societies and of Local Groups, so that membership is by virtue of membership in some other organization. A survey of the 35 then in existence was published by the Cincinnati Council last April. This survey, by Mr. Frank Sanford, Past President of the Cincinnati Council, has been widely publicized, and is available on request, so that no elaboration is required here.

5. The local Engineering Societies or Engineers Clubs, which have individual membership but which cut across the field and have members with all varieties of specialties. Probably all cities of over 100,000, and a great many smaller cities, have them, and in a great many cities they are the only local organization of engineers, and provide the only direct contact a great many engineers have with others of their profession outside of business hours.

Trade Associations or organizations having predominantly Company memberships should definitely not be included, since the object is to represent the interests of engineers as individuals. But the line must be carefully drawn here. Such Societies as ASTM with a combination of company and individual memberships should certainly not be excluded, at least as far as their individual memberships are concerned.

Whether technologists in other fields than engineering should be included is a moot point. Chemists, physicists, biologists, food technologists and the like are in several of the Local Councils. Probably they would not want to be included in a national engineering organization, but that is something for them to decide for themselves.

Second, *how?* A governing body for a national organization would be formed by having each member body select one representative for a period of three years, with the larger organizations having more than one representative, say on a basis of major fractions of 5,000. Thus a Society or Council with over 7,500 members would have a second representative, one with over 12,500 a third, one with over 17,500 a fourth, and so on. Confining these representatives to men who have held general elective office, such as past-presidents, past-chairmen, past-vice-presidents, etc., would assure experienced responsible talent. Terms would be staggered so that one third were elected each year. These men, and there might be a couple of hundred of them, would form the National Council. It would elect its own officers and the members of standing committees. The council would meet twice a year, and between times an Executive Committee composed of the officers and the chairmen of all standing committees would give effect to the decisions of Council. There would, of course, be a paid Secretary and staff.

In addition to the usual committees necessary to the carrying on of the business of the organization—Executive, Finance, Constitution & By-laws, Nominating, Membership, etc.—there would be a Standing Committee in charge of each activity the Council undertook. Additional activities could be undertaken, and additional Standing Committees formed to supervise

them, by say ⅔ vote of the entire Council membership at two successive meetings, which would mean that any controversial points could be discussed by the governing bodies of the member organizations, and their representatives instructed, before a final vote was taken. However, the President, with the approval of the Executive Committee, could appoint special committees having a limited term and advisory or temporary executive powers.

Third, and most important, *what?* This is the point where most of the disagreement occurs. There are many things the National Council might concern itself with, and some of them will be enumerated shortly. But what do the majority of engineers—the men the Council will be spokesman for—want? Nobody knows, and nobody can know. The issues have never been laid before them—there is no mechanism for doing it. And right there is the answer to the question. *Create the mechanism, lay the issues before them, and find out what they want!* That's all that is necessary to start with, and it's a big job. When the wants are known, the mechanism will be at hand to do something about them, with the safeguard to prevent going off the deep end that there must be a ⅔ vote at two successive Council Meetings, six months apart. After a few years there will be a variety of activities, but no one can predict today just what they will be. There are various cooperative activities going on today—to mention just one, the Engineers Council for Professional Development—and if it is deemed desirable, these activities can be blanketed in as Standing Committees without any break in the continuity of their work.

What is the mechanism for finding out what is wanted? Start a magazine which will go to each of the individual members of each of the member organizations, by virtue of that membership, in addition to the publications of his own organization. Discuss the issues—present both sides—and let the membership of the various Societies tell their representatives what they want.

The magazine would be divided into four main parts. The first part would be the policy articles—the social and economic status of engineers, licensing, collective bargaining, engineering education, pending legislation, standardization, sponsorship of research, patent policy, economic theory, national and international affairs, and similar subjects. Perhaps only 10 per cent will read the articles on any given subject, but 10 per cent of all engineers is in itself a large audience, and the rest will be proud to have the articles available, even if they don't read them. A magazine with the circulation we are talking about, going to all engineers, will be unique. There is nothing like it today, and it could command talent that none of the individual societies can touch. It will make it possible for the first time to lay before the entire profession the best thinking on both sides of issues of concern to engineers.

The second part of the magazine would be informative articles on engineering matters of general interest. It would be written from the standpoint of telling engineers what is going on in the engineering world outside of their own fields of specialization. Such things as regional planning; development, utilization and conservation of natural resources; flood control, city planning, superhighway system integration, new railway equipment, developments in radio, automotive engineering, frozen foods, new engineering materials and methods of their utilization, and the like, and also the technical matters which capture the public im-

agination from time to time and which the engineer feels he should know more about, such as nuclear physics and radar this year, would be discussed by authorities, but in a style which assumes only the basic engineering knowledge and viewpoint we all have, and popularizes the subject from there on. This type of article would have a tremendous popular appeal and a broadening influence on engineers' viewpoints and fields of knowledge which might well prove the most valuable thing to come out of the entire program.

The third part of the magazine would be the news of the organization and of the member organizations, and of engineers individually. It would include a series of writeups of the member societies and councils, cross-sectional studies of how various societies solve organizational problems common to all societies, news of elections, meetings, activities of general interest, etc. News of individual engineers would be primarily from the standpoint of activities of interest to all engineers, or of activities outside the technical field, such as in civic affairs. A very important part of this section would be a forum in which the individual was encouraged to express himself on the issues being discussed or bring up new issues for discussion. Editors say this is a hard department to run—if so, its success would be a measure of the editor.

The fourth part of the magazine would be a combined index of the technical parts of the publications of all member societies, and perhaps of commercial technical journals as well, with the articles classified as to type (new contribution, survey, polemic, etc.) and a brief description where the content is not evident from the title, so that the individual engineer could find out about articles of interest to him which appear in journals he does not normally see. Means would have to be provided for him to see the articles after he found out about them. This section would also carry book reviews and notices of publications of general interest, such as indices of standards and the like.

Finally, *who is going to pay for it?* Let each member group pay a $1 subscription to the magazine for each individual member. Where a man is a member of more than one group, split the dollar. Where membership in one group is by virtue of membership in another group which is already in the National Council, there would be no charge. Beyond that, the advertiser will pay for it. The magazine will be an advertising medium with a circulation from both the quantitative and qualitative standpoints which will be very attractive, and after it is once going, the magazine should not only pay its own way but should yield a profit which will support other activities of the Council as they are authorized.

In conclusion, the Council of the American Society of Refrigerating Engineers has authorized the writer to sit on an Organizing Committee to formulate a specific proposal and invite attendance at a general organization meeting to give effect to such a scheme and it has made an appropriation to help defray the expenses of such a committee. A number of other groups have been invited to do likewise, and it is quite possible that such a committee will be functioning within the next few months. The thought is to keep it small enough to function efficiently, and yet diverse enough so that its proposal will be generally acceptable, and will not represent domination by any group.

Hydrology in the Civil Engineering Curriculum

By H. W. WOOD, JR.
Professor of Civil Engineering, University of Missouri

The development of public works and private enterprises relating to water resources has been rapidly expanding during the last two decades and promises to continue expanding at an increasing rate for many years to come. The Tennessee Valley improvements, stimulated by the wartime demand for power, are approaching completion. The Grand Coulee and other great irrigation and power projects were interrupted but will now go forward. Flood control and navigation on the Mississippi and Missouri Rivers promise to furnish the largest coordinated enterprise of the post-war period while other valley development projects will undoubtedly be undertaken. The improvement of railways, highways, airports, waterways, harbor facilities, and public water supply and sanitary works will add to the backlog of hydraulic construction for years to come.

Much of this work must be sponsored by federal and local governmental agencies, because it offers no direct financial return which would attract private capital; but, no matter who initiates the various projects, much of the planning and construction must be directed by Civil Engineers who have a thorough understanding of the fundamentals of Hydrology. Some of these engineers will be in the employ of the public agencies and corporations, but a large amount of the planning and supervision will fall upon private engineering firms.

Few of the engineering schools have kept pace with these rapid advances and there has long been a demand for engineers who can handle hydrologic problems. Some of the schools have responded by including a required course in Hydrology in the Civil Engineering curriculum, and offering other elective and graduate courses in related topics; but the majority of engineering graduates have left school with inadequate conception of the fundamentals governing rainfall, runoff, routing, storage, and backwater, the very foundation of much hydraulic engineering practice. A little reflection will reveal the large variety of works which are based upon a reasonably accurate estimate of natural waters.

Stimulation of valley development has been brought about through the great destruction accompanying recurring floods. Communities tend to grow along water courses where, under natural conditions, they are in danger of periodic inundation. It is out of the question to argue that cities should be built on the hills. The fact remains that they are in the valleys and will stay there. So are rich farm lands, railways, highways, sewage plants, grain elevators and warehouses, and they must be protected from inundation by artificial control of flood waters. The city of Dayton, Ohio, was the first

large community to take effective steps toward elimination of the flood meance. The work of the Miami Conservancy District, with its elaborate studies of rainfall, runoff, and pondage, has been of inestimable value, not only to the successful protection of the Dayton area, but to the planning of hydraulic engineering projects everywhere. Johnstown has been protected from the ravages of the Conemaugh River. Pittsburgh, Louisville, and other cities along the Ohio River are to see that stream brought under a high degree of control. Regulation of the Sacramento River required perhaps the greatest skill in river hydraulics and hydrology of any major stream improvement in the country.

The comprehensive development of the water resources of the Missouri Valley at a cost of more than a billion dollars is going to require extensive hydrologic study for many years to come. The design, coordination, and operation of the intricate system of power, flood control, navigation, and irrigation units will require a high degree of hydrologic achievement. The control of the Ohio, Tennessee, Arkansas, and Missouri Rivers will go a long way toward prevention of floods on the lower Mississippi which is to have its share of new improvements. The new 60 acre scale-model of the entire Mississippi River system, being constructed near Vicksburg, indicates the importance of the central valley development in the post-war program.

The problem of flood abatement must fit in with hydro-electric power generation and navigation. Here the hydrologist is in a key position in design and location of reservoirs, dams, levees, and other works. The total water yield, the rainfall, infiltration and water losses, and the flood capacity of each drainage area must be determined and the flow routed through the tributaries and main stem.

Irrigation involves much more than distribution of water to the land. The availability of water and its proper storage-regulation must be determined according to hydrologic laws. More attention is being given to snow surveys as a valuable aid in predicting available water and flood hazards. Railways and highway departments no longer rely on empirical formulas for determination of the sizes of their drainage structures. Greater care is being given to the proper drainage of highway right-of-way and industrial plants while the drainage of airports has become essential to the development of commercial and military aviation.

The most universal use of water is in public water supplies. A few communities are fortunate enough to have sources which do not need the attention of a trained hydrologist in planning and operation, but many communities have inadequate supplies, and must turn to new sources in artificial reservoirs, streams or wells. Stream pollution is becoming a major problem as the urban populations become more civic-minded and as public health departments progress in their clean-up campaigns. Future growth and industrial expansion of a community require increasing quantitities of potable water. Much of the planning of water supply and sewage disposal is conducted by private engineering firms but at public expense.

The great interest in hydrologic science today extends also to the fields of forestry, soil conservation, and scientific agriculture. Many important contributions to the science have come from these sources.

Further evidence of the growing importance of the subject is seen in the amount of space it occupies in engineering and scientific publications. A large proportion of articles in engineering magazines and *Transactions* of the American Society of Civil Engineers are on topics in which hydrology is fundamental, and far more than half of the space in the *Transactions* of the American Geographical Union of the National Research Council is devoted to papers and reports of the Section of Hydrology.

The following list of topics is suggested as appropriate for inclusion in an introductory course in hydrology.

1. Precipitation
   - Meterology
   - Measurement of rainfall
   - Estimating rainfall
2. Disposition of Precipitation
   - Hydrologic cycle
   - Interception, evaporation
   - Infiltration, transpiration, soil moisture
   - Water yield
   - Ground water
   - Surface runoff
   - Flood flow
   - Formulas, hydrographs, duration curves, statistical studies, unit hydrographs, hydraulic methods.
3. Control of Water
   - Storage
   - River mechanics
   - Flow routing
   - Backwater
4. Measurement of Stream Flow
   - Gaging stations—controls
   - Rating curves
   - Recording instruments
   - Current meters
   - Weirs
   - Contracted openings
   - Slope-area method

In view of the fundamental character of hydrology, the widespread interest among natural scientists, and the demand for hydrologists in present-day engineering projects, it seems reasonable to include the subject in all Civil Engineering curricula.

Teaching and Practicing Electrical Design

By NICHOLAS M. OBOUKHOFF

Research Professor, The Oklahoma A. and M. College

SUMMARY

Pedagogy and practice of electrical design together with their relations constitute the subject matter of this article. The objectives of study are specifically treated in three parts.

Part I proposes to state and discuss concisely general principles and procedures of a method of successive approximations, which are important both in teaching and practicing electrical design.

Part II is self-sufficient, on the one hand, and serves as an illustration of application of Part I, on the other, being concerned with new methods of designing a direct current magnetizing coil. Section I of Part II deals with a direct method while the other section is devoted to a method of correlation; examples conclude Part II.

A new method of prefinal transformer design, presented as an abstract, is the topic of Part III; it can be considered as self-sufficient and also as another illustration of application of Part I.

PART I

METHOD OF SUCCESSIVE APPROXIMATIONS

It is known that a preliminary design of an electric machine or apparatus can be obtained on a basis of empirical data such as flux densities in magnetic circuits, current densities in electric circuits, specific loadings and constants in output formulas, etc.

This phase of a design usually gives a designer a more or less rough approximation; a final stage is reached from the latter by successive trials so that assigned requirements should be met within limits of practical allowances; the phase which is followed immediately by the final one will be called prefinal.

As a matter of fact, indications or suggestions as to how those trials should be undertaken and conducted are not available in a form of a systematically arranged procedure both in technical literature and in actual practice, thus leaving it either to judgment or merely to chance to decide on a procedure to follow.

The purpose of this paper is to outline a consistent and logical sequence of successive approximations leading under circumstances most directly to a final design.

Another emphasis is laid throughout the study on a correct interpretation of a temperature requirement in the light of economical design. This requirement must not be understood in a one-sided manner—in a sense that a temperature of an apparatus or machine (or their elements) should not exceed a permissible limit without taking into consideration a lower limit which should be pretty close to the upper limit. The lower limit requirement deals with an economical aspect of a design because an unduly low temperature indicates that either too elaborate methods of cooling are applied, or unnecessarily large amounts of principal materials are used, or both.

The elimination of an economical waste would, in this case, bring about an increase in the temperature which must not, of course, exceed the upper limit.

Accordingly, the highest technically permissible temperature will be considered as the most economical and termed a desired temperature—naturally within plus and minus practical allowances or, in other words, this temperature will serve as one of the criteria of the most economical design. Furthermore, the *general* adjustment of a preliminary design to the requirements of economy is as much of a concern in this study as a merely technical approach to the problem.

This means that not only the temperature criterion but also other economical criteria, general as well as specific in their application to particular types of machines or apparatus, are used in the adjustment.

It is often contended that an economical design procedure can not be systematized because it depends primarily on specific empirical data. There is truth in this assertion in so far as minute details and painstaking computations are involved in an actual total cost determination. However, a problem of *relative costs* of several design *variants of one and the same* machine or apparatus is, to some extent, different from that of actual total expenses of building a machine or apparatus, including also the total cost of materials.

It is more than fairly true that a variant with the minimal cost of principal materials, iron and copper, is also connected with the minimum of the total manufacturing expenses; for, on the one hand, this variant is close to that with the minimal total weight of the same materials,* and on the other hand, the total cost of labor and other shop and transportation expenses are correlated with the total amount of principal materials in the way that both the items increase or decrease together so far as *design variants of one and the same machine or apparatus are concerned.*

This makes it possible to apply the minimal cost of principal materials as another general criterion of the most economical design variant without going into a determination of details and computation of a total cost. It is well known that the determination of general dimensions of a machine or apparatus is sufficient for a calculation of the cost of *principal* materials.

The general methods and criteria characterized in the foregoing can effectively be applied in teaching as well as practicing electrical design; the experience of many years in both has convinced the writer that one can, in this manner, raise a level of instruction and make classroom design *approach* actual industrial design and acquire some realistic traits of the latter, although the former can never reach that finality which belongs to the latter only; this limitation is fully realized; yet the usefulness of the procedure even with the above restriction stands out beyond any question in pedagogy and practice of design in its prefinal stage, especially if a project is outside routine.

Besides general methods of tackling a problem of the most economical design, there are also *semi-general* procedures applicable only within separate

* A cost curve of principal materials more often than not shows its minimum point close to that of their total weight curve, within the limits of a series of design variants of one and the same machine or apparatus.

classes of machines or apparatus such, for example, as direct current dynamos, alternators, transformers, etc.

Part II that follows immediately Part I is self-sufficient in itself, on the one hand, and can serve as an example of the application of the above general and semi-general procedures, on the other. The foregoing remark applies also to the concluding Part III.

PART II

DESIGN OF A DIRECT CURRENT MAGNETIZING COIL

(New Methods)

Section I. *Direct Method*

A direct current magnetizing coil is a substantial part or element of most electrical machines and apparatus. It is exemplified as mounted on an electromagnet in Figs. 1–4 showing openings of circular, rectangular and also other perimeters. Usually the conditions or requirements which should be complied with or fulfilled by a designer are, as follows:

1. A terminal voltage V; it may be postulated by line voltage or otherwise.
2. A required number of ampere-turns (ni) where n is a number of winding turns and i a current in a winding.
3. An outside surface temperature rise T_r; in other words, a difference of the surface temperature of a coil and an ambient temperature.
4. Also very often a size and shape of a coil opening.
5. Sometimes special requirements or conditions are imposed as to the length or width of a winding space or both; we call them simply the length and width, or thickness, of a coil.
6. V is given as prescribed by a current source; (ni) and also a size and shape of a coil opening are usually predetermined on the basis of a magnetic circuit specification and performance of an electrical machine or apparatus; a temperature rise T_r is mostly chosen within limits depending on an ambient temperature and *restrictions imposed by insulating materials at the hottest spot inside a coil*, or, in other words, an appropriate temperature T_A there is assumed.

There are given: number of ampere-turns (ni); outside temperature rise T_r; terminal voltage V; opening of a coil, p being the length of its perimeter.

There are sought: size of conductor, *i.e.* its cross-section area q; winding space given by l and w, its length and width respectively, which are at the same time length and thickness of a coil; number of turns n.

The derivations are brought about by using auxiliary formulas, as follows: The electrical joule losses or generated heat in watts

$$W=i^2R=\frac{V^2}{R}; \qquad (1)$$

R being total resistance of a coil at average temperature of wire.

The length of a mean turn

$$m=p+kw \qquad (2)$$

where $k=\pi$ for a circular opening (Fig. 2) and $k=4$ for a rectangular opening in Fig. 3, but for a similar coil with perfectly rounded outer corners $k=\pi$; also for an opening represented in Fig. 4, $k=\pi$; however, for a coil with rectangular opening, whose outer corners are not perfectly rounded $\pi<k<4$; the first plausible assumption would be to make averagely $k=3.57$ in this case.

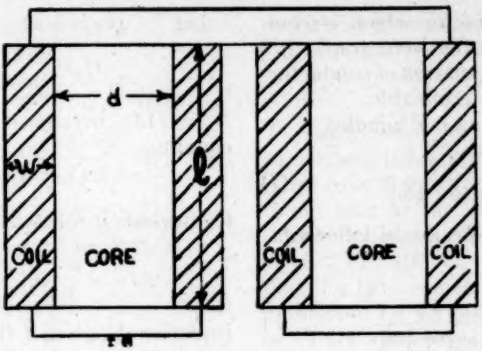


FIG. 1

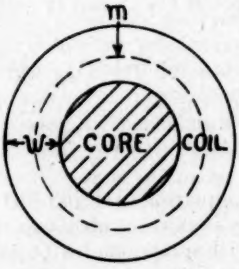


FIG. 2

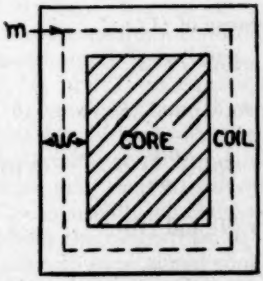


FIG. 3

FIG. 4

The cooling surface

$$A=2mw+pl+(p+2kw)l$$
$$=2(w+l)(p+kw)=2m(w+l). \quad (3)$$

The outside temperature rise

$$T_r=\frac{W}{cA}; \quad (4)$$

where c is the cooling coefficient, A area of the cooling surface and W is given by (1). If ω designates resistivity at the *average* temperature of coil wire the total winding resistance

$$R=\frac{\omega n(p+kw)}{q}. \quad (5)$$

The number of winding turns

$$n=\frac{slw}{q}, \quad (6)$$

s is the space factor which is computable or available from graphs if q and a mode of insulation of conductors are known or determinable.

The current in a coil winding

$$i=\frac{Vq}{\omega n(p+kw)}. \qquad (7)$$

Further derivations are as follows:*

Because of (7)

$$(ni)=\frac{Vq}{\omega(p+kw)}. \qquad \text{I}$$

Referring to (4),

$$W=cT_rA. \qquad (8)$$

Again, because of (1)

$$i^2R=cT_rA. \qquad (9)$$

Referring to (2) and (5)

$$R=\omega\frac{nm}{q}. \qquad (10)$$

Then from (9) and (10)

$$i^2R=i^2n\omega\frac{m}{q}=i(ni)\omega\frac{m}{q}=cT_rA. \qquad (11)$$

Again, denoting current density by Δ, it obtains

$$i=q\Delta;\ \Delta=\frac{(ni)}{swl} \quad \text{and} \quad i=q\frac{(ni)}{swl}. \qquad (12)$$

Substituting (12) for i and (3) for A we derive from (11) the fundamental equation

$$\omega\frac{(ni)^2}{swl}=2cT_r(w+l). \qquad \text{II}$$

Then

$$\frac{\omega(ni)^2}{2wscT_r}=lw+l^2. \qquad (13)$$

Let

$$Q_w=\frac{\omega(ni)^2}{2wscT_r}. \qquad \text{III}$$

Now (13) transforms to quadratic equation

$$l^2+wl-Q_w=0 \qquad \text{IV}$$

from which it follows that

$$l=-\frac{w}{2}+\sqrt{\frac{w^2}{4}+Q_w}. \qquad \text{V}$$

Equation V gives l in terms of the assigned or assumed data, w being among them.

Likewise from equation II we get finally—if l is known or assigned

$$w=-\frac{l}{2}+\sqrt{\frac{l^2}{4}+Q_l}, \qquad \text{VI}$$

where

$$Q_l=\frac{\omega(ni)^2}{2lscT_r}. \qquad \text{VII}$$

Both equations III and VII are practically important although only auxiliary. Expressions for Q_w and Q_l can be given other forms. Let us substitute for (ni) its expression from I; then finally

$$Q_w=\frac{qV^2}{2wsR_m(p+kw)cT_r}, \qquad \text{III}_a$$

$$Q_l=\frac{qV^2}{2lsR_m(p+kw)cT_r}, \qquad \text{VII}_a$$

where R_m stands for resistance of a mean turn at the average temperature of a coil.

Likewise substituting from (4), it obtains

$$cT_r=\frac{1}{A_1} \quad \text{and} \quad A_1=\frac{1}{cT_r}, \qquad (14)$$

where A_1 stands for A/W and denotes area of the cooling surface per 1 watt dissipated; formulas III and VII, also

* Roman numerals are used to indicate *practically* important formulas or *fundamental* equations.

III_a and VII_a, transform to

$$Q_w=\frac{\omega A_1(ni)^2}{2ws}=\frac{qA_1V^2}{2wsR_m(p+kw)}, \quad III_b$$

$$Q_l=\frac{\omega A_1(ni)^2}{2ls}=\frac{qA_1V^2}{2lsR_m(p+kw)}. \quad VII_b$$

Raising equation (6) to the rank of practically important we write

$$n=\frac{swl}{q}. \quad VIII$$

There are now *three* fundamental equations, namely: I, V (or VI) and VIII, to determine *four* basic magnitudes that constitute a coil, *i.e.*, q, w, l and n. This is practically an advantage because it makes a design adaptable to other requirements arising from structural and economical considerations.

Suggestions and Remarks: There are cases in which w must or can be estimated on the basis of some specific conditions or considerations; for example, field coils of a machine may call for this estimation. With an opening known or assigned and average temperature T_a of winding reasonably assumed or estimated, equation I makes it possible to compute q for an assigned number of ampere-turns; then if necessary, it is rounded to a wire table figure; a more accurate value of w should be then computed from equation I substituting there the above table value; using now equations III (or III_b) and V, l becomes computable.

Denoting an ambient temperature by T, outside and inside temperature rise by T_r and T_i respectively, hottest spot and average temperature by T_h and T_a respectively, it obtains

$$T_h=T+T_r+T_i \quad (15)$$

and also with sufficient accuracy

$$T_a=T+T_r+\frac{3}{5}T_i, \quad (16)$$

T_i usually varies from 5° C to 30° C as ampere-turns change within the range from 500 to 18,000. For a continual load in the absence of exceptional conditions, it is suggested that $95° C \leqq T_h < 100° C$. It is understood that if a load is intermittent or space limitations are stringent higher values of T_h are allowable, but in the latter case this would, of necessity, shorten the life of a coil. The cooling coefficient c usually varies from 0.005 to 0.010 depending on the nature of an ambient medium, conditions of ventilation, etc. Substituting values for T, T_h and T_i in equations (15) and (16) one finds T_r and T_a which in combination with chosen c and w will set the system of the fundamental equations and their auxiliaries to work. T_a can usually be chosen beforehand within the range from 85° C to 95° C under no exceptional conditions such, for instance, as drastic limitations of winding space.

Another approach to a design is to begin with reasonable assumption of A_1 instead of the temperatures and cooling coefficient; then equation III_b or VII_b should be used. Usually A_1 varies within the range from 2 to 5, being about 3.5 for average cases. Also there are situations which require that l should be estimated first and then w determined from equations VI and VII. Since q is not yet known in this case, space factor s should be estimated and checked afterwards.

The following half-empirical formulas for an estimation of T_i and w at the beginning of design or otherwise are offered as helpful and adequately accurate in the case of continual serv-

ice within the limits $500 \leqq (ni) \leqq 18{,}000$ and somewhat beyond them:

$$T_i = 5.5\sqrt{\frac{(ni)}{500}} \qquad (17)$$

and

$$w = 3\sqrt{\frac{(ni)}{18{,}000}}, \qquad (17_a)$$

where T_i is expressed in degrees C and w in inches.

Section II. *Method of Correlation*

The method of correlation is applicable in a number of cases as follows:

1. To obtain the final design from that one which has been brought about as preliminary;
2. To reach a final design from results observed on an experimental coil;
3. To provide series design for a variety of coils under different conditions of assignment and service by transformations of *one* preliminary or successful design carried out for some *particular* case as well as from correlated observations on *one* experimental coil;
4. To develop a parallel design of several variants to find that one which would be optimum.

Practically the number of the applications of the method is unlimited.

The following *Table of Notation and Correlation* is offered as a convenient auxiliary in presentation of the method and its applications.

The table speaks for itself: in the first column general symbols are given; in the second there are entered the symbols pertaining to specific values obtained either from a preliminary or successful design as well as possibly from the observations on an experimental coil, all being indicated by subscript 1; likewise in the third column final values are designated by subscript 2 while the fourth column gives generic meaning or definition of the symbols in columns 1, 2 and 3.

To obtain the correlations between the values of columns 2 and 3 respectively in the most generalized form, the difference between the conditions is pushed as far as possible even assuming, for example, that dissimilar conductor materials are used in both cases, this being expressed in different values of the resistivities ω_1 and ω_2; that cooling conditions are not the same, which is reflected in different values of the cooling coefficient c_1 and c_2 or A_{11} and A_{12} and also will influence to some extent the difference between ω_1 and ω_2 and that likewise the magnetic circuit specifications are different which is clear from the fact that p_1 and p_2 are not alike, etc.

Using the procedure similar to that of Section 1 it is found to be

$$\frac{q_2}{q_1} = \frac{\alpha\omega_2 V_1(p_2 + k_2 w_2)}{\omega_1 V_2(p_1 + k_1 w_1)}, \qquad I'$$

where

$$\alpha = \frac{(ni)_2}{(ni)_1},$$

also

$$w_2 l_2^2 + w_2^2 l_2 = Q, \qquad II'$$

where

$$Q = \frac{s_1}{s_2}\left[\frac{c_1}{c_2}\frac{\omega_2}{\omega_1}\frac{\alpha^2}{\mu} l_1 w_1 (l_1 + w_1)\right] \qquad III'$$

and

$$\mu = \frac{T_{r2}}{T_{r1}}.$$

Substituting A_{11} for $1/T_1 c_1$ and A_{12} for $1/T_2 c_2$ it becomes

$$Q = \frac{s_1}{s_2}\left[\frac{A_{12}}{A_{11}}\frac{\omega_2}{\omega_1}\alpha^2 l_1 w_1 (l_1 + w_1)\right]. \qquad IV'$$

TABLE OF NOTATION AND CORRELATION

General	First Values (Preliminary)	Desired Values or Derivable From First Values (Final)	Meaning or Definition
T_r	T_{r1}	T_{r2}	*Outside* surface temperature *rise* or difference between temperature of a coil surface and ambient.
n	n_1	n_2	Number of turns of a coil winding.
i	i_1	i_2	Current in a coil winding (magnetization or excitation).
(ni)	$(ni)_1$	$(ni)_2$	Number of ampere-turns of a coil winding.
l	l_1	l_2	Length of a coil. Figs. 1–4.
w	w_1	w_2	Width or thickness of a coil. Same figures.
m	m_1	m_2	Length of a mean turn. Figs. 1–4.
V	V_1	V_2	Terminal voltage. (Current source voltage at the terminals of a coil.)
A	A_1	A_2	Cooling coil surface.
q	q_1	q_2	Cross section area of a conductor used in a coil winding.
ω^*	ω_1	ω_2	Resistivity of a conductor material at the average temperature of a coil.
R	R_1	R_2	Total resistance of a coil winding at the average temperature of a coil.
s	s_1	s_2	Space factor of a coil winding.
W	W_1	W_2	Electrical losses in a coil. Amount of heat generated in watts.
c	c_1	c_2	Cooling coefficient of a coil surface.
p	p_1	p_2	Length of a perimeter of a coil opening.
α			$\frac{(ni)_2}{(ni)_1}$.
μ			$\frac{T_{r2}}{T_{r1}}$.
k	k_1	k_2	k is the coefficient in $(p+kw)$ where $k=4$ for a rectangular opening; $k=\pi$ for a similar coil but with perfectly rounded outer corners; $k=\pi$ for a circular opening, also for an opening represented in Fig. 4; however, for a coil with rectangular opening, whose outer corners are not perfectly rounded, $\pi<k<4$; it is suggested that $k=3.57$ as the first assumption.
Q			$\frac{s_1}{s_2}\left[\frac{c_1}{c_2}\frac{\omega_2}{\omega_1}\frac{\alpha^2}{\mu}l_1w_1(l_1+w_1)\right]$.
T_h	T_{h1}	T_{h2}	Hot spot temperature.
T_i	T_{i1}	T_{i2}	*Inside* temperature *rise* or difference between *hot* spot temperature and surface temperature.
T_a	T_{a1}	T_{a2}	Average inside temperature of a coil winding.
T	T_1	T_2	Temperature of an environment (ambient).
Δ			Current density.
A_1	A_{11}	A_{12}	Cooling area per 1 watt dissipated.

Remark: Space factors s, s_1, and s_2 are functions of q, q_1, q_2 and insulation. They are computable or available from graphs if q is known and a mode of insulation is chosen.

* $\omega=b\times10^{-7}$ ohms per one inch length and one square inch area of cross-section of copper wire; in this formula b equals 7.9 at 60° C; 8.37 at 75° C; 8.7 at 85° C; 9.02 at 95° C and 9.48 at 110° C.

Solving II′ it obtains

$$\left.\begin{aligned} l_2 &= -\frac{w_2}{2}+\sqrt{\frac{w_2^2}{4}+\frac{Q}{w_2}} \\ \text{or} \\ w_2 &= -\frac{l_2}{2}+\sqrt{\frac{l_2^2}{4}+\frac{Q}{l_2}} \end{aligned}\right\} \quad V'$$

The equations and formulas of Section II are similar to those of Section I; however, expression for Q shows some dissimilarity.

Equations I′, III′ (or IV′) and V′ make it possible to find q_2 and l_2 (if w_2 is assumed or estimated) or w_2 (if l_2 is assumed or estimated) on the basis of the already known and correlated values designated by subscript 1, on the one hand, and assigned (desired) or estimated magnitudes of the second case indicated by subscript 2, on the other. In general, they should be treated and used in the manner established for the similar formulas of Section I. Likewise, formula VIII and the article "Suggestions and Remarks" of the same section are fully applicable in the correlation method.

If the fluctuations or changes of terminal voltage V are not negligible, it is recommended to determine q or q_2 from equation I (Section I) or I′ (Section II) respectively for the *lower* limit of V in order to secure an assigned or desired value of ampere-turns under unfavorable conditions; on the other hand, the joule losses and accordingly temperature rise should be computed for the higher limit of V. As a good approximation it is recommended to raise the estimation of both T_r and T_i by double percentage excess of maximum V over its normal level if the deviation is expected to last some time; this is because losses and temperature rise are proportional to V^2 for the same coil; for instance, if the percentage excess of the higher limit over normal value of V is 12 per cent, the percentage increase of both T_r and T_i will be close to 25 per cent which can hardly be ignored if it is *durable*.

If only a temperature adjustment is required or desired, this can be done—without impairing the ampere-turns—in one or the other simple manner as follows: to reduce the temperature of a coil add new turns while keeping q and m in the additional winding same as in the original one; this procedure will increase R and l, which will make losses decrease and cooling surface increase, the result being a lower temperature with negligible increase in the ampere-turns because of a lower temperature and somewhat smaller resistance; in this case the reference is made to equations (1) and I (of Section I) and I′ (of Section II).

The second procedure leaves l unchanged and provides for additional turns over the original coil;* in this case, however, q_2 of the new turns should be larger than q_1 of the original ones; it can be determined with good approximation from equation

$$q_2 = q_1\frac{(p+2kw_1)}{(p+kw_1)} \qquad (18)$$

in order that the ampere-turns should not be affected materially by the additional winding. Formula (18) can easily be explained by taking into consideration that $p+2kw_1$ represents closely the length of a mean turn of the additional winding and that to make its resistance approach close that of a mean turn in the original winding it is necessary to increase q_2 over q_1 in the shown proportion otherwise the ampere-turns would be

* There will be only few *layers* of additional winding.

affected. While adjusting q_2 to wire table size take the larger one.

It depends upon an actual situation which of the two procedures should be followed; however, if there is a choice prefer the first one; it will be more economical.*

Remark: In many a case the Direct Method, Section I gives forth a final design; if not, the result will be its pre-final stage. At any rate, the application of the Direct Method considerably shortens the whole procedure of design.

Examples

Section I. *Direct Method*

Given (assigned): ampere turns $(ni) = 3760$; Terminal voltage $V = 115$; room temperature $T = 25°$ C; diameter of the coil opening $d = 4''$.

According to the foregoing, hot spot temperature T_h should be within limits of $95° \text{ C} \leqq T_h < 100° \text{ C}$; let us choose $T = 95°$ C; then according to equation (17) inside temperature rise $T_i = 15.1°$ C, let it be 15° C. From equation (15) we find outside temperature rise $T_r = 95 - 25 - 15 = 55°$ C and from (16) average temperature of coil winding $T_a = 25 + 55 + 10 = 90°$ C.

Further computations and their results are presented as follows (see also Table of Notation and Correlation):

$w = 1.37''$ from (17a), $b = 8.86$, $\omega = 8.86 \times 10^{-7}$ for $T_a = 90°$ C, $m = 16.85''$ from (2), $q = 0.0004900$ sq. in. from basic equation I, No. 22 copper wire of B and S gauge table being chosen, with $q = 0.0005030$ sq. in. very close to that computed; using $c = 0.0055$, $s = 0.46$ from graphs,† $T_r = 55°$ C and $\omega = 8.86 \times 10^{-7}$ as computed, to substitute in basic equations V and III there obtains from the latter $l = 5.1''$; number of winding turns $n = 6{,}400$ from (6); length of winding wire $L = \dfrac{6{,}400 \times 16.85}{12} = 9{,}000$ feet; total resistance of coil winding at 90° C $R = 200$ *ohms;* current in coil winding $i = 0.575$.

Let us check the actual ampere turns and temperatures as follows: actual $(ni) = 0.575 \times 6{,}400 = 3{,}680$ versus 3,760, deviation of -2.13 per cent only; actual cooling surface $A = 218$ sq. in. from (3); actual losses (heat) in the coil $W = 66.3$ watts p. s.; accordingly, actual outside temperature rise $T_r = 56°$ C from (4), which agrees very well with 55° C computed on the basis of hot spot temperature and inside rise in the foregoing.

The computed dimensions and performance of the coil (w, l, m, W, ni, etc.) make it possible to check inside temperature rise T_i obtained previously by means of equation (17) in the very beginning of the design, now using other formulas for computation, for instance, that proposed in "Elements of Electrical Design," by Mr. Alfred Still, pp. 328–9; thus we have $T_i = 15.8°$ C versus 15.1° C anticipated by much simpler formula (17). The hot spot temperature now appears to be $T_h = 25 + 56 + 15.8 = 96.8°$ C which agrees well with the imposed limits $95° \text{ C} \leqq T_h < 100° \text{ C}$.

Section II. *Method of Correlation*

Assignment: Let us change ampere turns from $(ni)_1 = 3{,}760$ to $(ni)_2 =$

*In both the procedures the number of *turns* is finally increased, yet *ampere-turns* remain practically *unchanged* because current i decreases in the same proportion in which number of turns n is increased (increased resistance).

†See, for example, "Elements of Electrical Design," by Mr. Alfred Still, p. 35.

10,000; $V_1=115$ to $V_2=230$ volts, and change also the opening from circular to square with sides equal to 4".

Now from the formulas used in the foregoing example and Table of Notation and Correlation we get:

$$T_{i2}=5.5\sqrt{\frac{10,000}{500}}=24.6^\circ\text{ C},$$

rounding it to 25° C,

$$w_2=3\sqrt{\frac{10,000}{500}}=2.26'',$$

$$T_{r2}=95-25-25=45^\circ\text{ C},$$

$$T_{a2}=25+45+15=85^\circ\text{ C},$$

$$\omega_2=8.7\times10^{-7},\quad m_2=24.07''$$

(corners are not perfectly rounded), $\alpha=2.66$; then from I′ of Section II

$$\frac{q_2}{0.0005030}=266\times\frac{8.7}{8.86}\times\frac{115}{230}\times\frac{24.07}{16.85}=1.862,$$

$q_2=0.0009500$ sq. in.; let us take $q_2=0.0010120$ as the closest figure in B and S gauge wire table (No. 19); therefore correction of w_2 and m_2 to new values of w_2' and m_2' is carried out as follows:

$$\frac{q_2}{q_1}=\frac{0.0010120}{0.005030}=2.01;\text{ by inspection}$$

of formula I′ it is easy to see that

$$\frac{m_2'}{m_2}=\frac{2.01}{1.862}$$

and

$$m_2'=\frac{2.01}{1.862}\times24.07=26.2'';$$

now $p_2=4''$ and $k_2=3.57$ and from formula (2) of Section I

$$w_2'=\frac{26.2-16}{3.57}=2.86''.$$

Using the procedure as indicated in the foregoing example for Section I, we further obtain

$$l_2=9.76'',\ T_{r1}=47.5^\circ\text{ C},\ T_{i2}=24.8^\circ\text{C},$$

by A. Still's formula against 25° C as computed above by formula (17) of Section I and $(ni)_2=10,300$ against 10,000 as assigned, $T_{h2}=97.3^\circ$ C. Everything checks well. To compute l_2 one can use also formulas IV′ and V′ of Section II. The results differ by negligible amount of about 2 per cent.

As an extension of illustration of the method of successive approximations two following publications are referred to:

Nicholas M. Oboukhoff, Discussion, pp. 993–994, Supplement *Transactions AIEE*, Vol. 61, 1942.

Same author, "A New Method of Designing Transformers," Preliminary Communication, *Proceedings of the Oklahoma Academy of Science*, Vol. 24, 1944.

Likewise, Part III serves the same purpose of broadened illustration.

PART III

METHOD OF PREFINAL TRANSFORMER DESIGN

(ABSTRACT)

New formulas to serve as foundations for a rational modernized prefinal design for transformers are presented as follows.

$$\Delta=(k/\alpha)\sqrt{\eta K_c/K_s},\qquad(1)$$

where Δ denotes the current density, α, the root-mean-square (rms) load factor; η, the core loss per pound of steel laminations; K_c, the cost of winding conductors per pound; K_s, the cost of core laminations per pound; and

the value of k depends upon the average temperature of the conductor, being 715 for 80° C, 700 for 90° C, 685 for 100° C, 675 for 110° C, and 665 for 120° C.*

$$A_s = C\alpha\sqrt{[(KVA)/4f][\Delta/\eta B]}\times 10^3, \quad (2)$$

where A_s denotes the net metallic cross-section area of the core; (KVA), the output in kilovolt-amperes; f, the frequency; B, the flux density in the core; and C is the output constant which usually varies within the limits of 0.30 to 0.55 for a single-phase, core-type transformer, averagely $C=0.425$. The lower values of C are intended for higher voltages.

$$B_{\alpha'}/B_{\alpha''} = \sqrt{\alpha'/\alpha''}, \quad (3)$$

where $B_{\alpha'}$ and $B_{\alpha''}$ are flux densities for α' and α'' rms values of load factor respectively. The formula (3) may be given the particular form

$$B_\alpha = 98{,}500\sqrt{\alpha} \quad (4)$$

for all practical values of α.

Where α_0 represents a usual load factor, this is the ratio of the arithmetical average load to peak load, while α represents the ratio of rms load to peak load. It is empirically found that α exceeds α_0 by the amount $d\alpha_0$ so that

$$\alpha = \alpha_0 + d\alpha_0, \quad (5)$$

$$d\alpha_0 = 0.08(1-\alpha_0). \quad (6)$$

The following formula is also useful for consideration:

$$\text{loss ratio} = 1/\alpha^2 \quad (7)$$

which means that the ratio of copper loss to that in the core should be correlated with rms load factor.

With the rated high and low tension voltages given and Δ, A_s, and B computed from the foregoing equations the designer is in position to find the number of turns of the windings and the size of the conductors for the desired α or α_0; in other words, the fundamental characteristics of the electric circuit will then be outlined. As to the magnetic circuit, in addition to A_s a tentative length for the mean magnetic path l_m is made determinable by the following equation for a single-phase core-type transformer,

$$l_m = [\alpha^2/(1+\alpha^2)][(1-e)/\eta e] \times[(KW)/\gamma A_s], \quad (8)$$

where e denotes efficiency and γ the specific weight of steel laminations.

* The foregoing values of k are recommended if the saving of copper takes precedence over the optimum efficiency of operation. In the latter case, however, the following values of k would be preferable: 670, 655, 640, 630 and 620 for 80° C, 90° C, 100° C, 110° C and 120° C respectively, or even somewhat lower.

College Notes

Newark College of Engineering.—A $2,700,000 building program that includes a 20-story "educational skyscraper was announced Feb. 27. The expansion calls for three units to be erected on the College's High Street and Summit Place property.

The natural elevation of High Street will raise the monumental tower to a height of about 350 feet, making it one of the predominant buildings in the Newark skyline. The construction will be divided into three stages with a four-story addition to the existing laboratory building in Summit Place first on the schedule. The administration offices and classrooms paralleling High Street will then be rebuilt with three floors added, making it six stories. The first two units will adjoin the skyscraper which will be erected last.

Unit No. 1 will entail an expenditure of $300,000, housing greatly enlarged laboratory facilities and new equipment. Located on the main floor will be the heavy machinery—generators, airplane engines, motors, etc.—for mechanical and areonautical engineering. The remaining floors will be assigned to physics, chemistry, electrical and electronics equipment.

Unit No. 2 will cost $400,000, and will include the administrative offices, lecture halls, library, museum, cafeteria, swimming pool, auditorium and gymnasium.

Unit No. 3, a two million dollar tower, will contain classrooms, student activities areas, club rooms for professional engineering societies and college organizations, faculty and student lounges and a coffee shop. A glass solarium will top the structure and may eventually be used in connection with radar experimentation.

The School of Engineering of **Washington University** announces the appointment of Leonid Michael Tichvinsky as Associate Professor of Mechanical Engineering; and of Robert E. Newton as Assistant Professor of Applied Mathematics.

American Institute of Electrical Engineers.—The 1945 Lamme Medal of the American Institute of Electrical Engineers has been awarded to David C. Prince, Vice President, General Engineering and Consulting Laboratory, General Electric Company, Schenectady, N. Y.,

> For his distinguished work in the development of high voltage switching equipment and electronic converters.

The medal will be presented at the Summer Convention of the Institute to be held in Detroit, June 24–28.

Society for the Promotion of Engineering Education

NOMINATIONS FOR 1946–47

For President .....

For 1st Vice Pres. .....

For 2nd Vice Pres. .....

For Members of Council for three years
(7 to be elected)

.....

.....

.....

.....

.....

.....

.....

.....

(signed) .....

(address) .....

(date) ....

Names of nominees, "on the form provided," must reach the secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh 13, Pa., not later than May 15, 1946.

Horizontal Options through Major Engineering Curricula

One Solution to the 4-Year Quandary

By L. E. GRINTER

Vice President, Illinois Institute of Technology

We have traditionally approached the subdivision of engineering education by maintaining alignment with the branches of engineering practice (civil, electrical, mechanical, etc.) and with the engineering societies. These are vertical subdivisions of the broad field of engineering. They are artificial in the sense that the work of an individual engineer often extends through two or more such subdivisions and they are overlapping.

We know by experience that a student who can become successful in one branch of engineering can be about equally successful in any other branch, both as a student and later as an engineer. Choice between these branches should be made, therefore, primarily upon the basis of the interest of the student since the necessary aptitudes are about the same for all. It is clear that job classifications within each branch of engineering (compare design with maintenance, for example) permit much greater variations in aptitudes than do similar job classifications in different branches of engineering.

Research and Development versus Management. Two job classifications, research and development on the one hand and management on the other, appear to be near the opposite ends of the spectrum as regards required aptitudes, and this is true through all branches of the profession. In the research and development engineer, one recognizes either the need for unusual competence in applying mathematics to engineering problems or ingenuity in conducting laboratory experiments, preferably both. In the management engineer, the aptitudes for organization of processes and for the handling of men seem paramount. Of course, each of these individuals would be strengthened by having some of the qualifications of the other in addition to his own, but he can become successful without these extra aptitudes.

The 4-Year Quandary. If we examine our past procedures, we see that our traditional plan of one four-year curriculum in each branch of engineering grew up during a period when engineers performed far more limited functions than they do today. Before 1910, research and development was called "invention." Few if any companies maintained research laboratories. Engineers were seldom hired for the direct purpose of improving or developing new consumer products. Engineering educators felt no pressure to train people for these nonexistent jobs. But by the late 1930's one sur-

vey indicated that some 15 per cent of engineering graduates entered research laboratories without preparation beyond the B.S. degree, and it seems clear that this percentage is due to increase.

Looking back to 1910 again, we recall that success was often measured by achievement as a consulting engineer or at least by private practice. Special qualifications and training for management in industry would have found few employment opportunities. The acceptance of engineering training as a vital force in industrial management is of more recent origin and is still in its infancy. Accordingly, the demand for training in management was not a major force in the early development of our curricula.

If industry had been interested in engineers for research and for management positions during the formative years of engineering education, our curricula would look different today. The 4-year quandary would have been resolved long ago either by the adoption of longer curricula or by the establishment of broad horizontal options through all curricula. It is clearly impossible to train the same person adequately for such diverse functions as research, operation, design and management in four years, not forgetting our obligation to produce cultured citizens of all.

Non-professional Service. If all engineering graduates were destined for true professional service, longer curricula with their selective action would be a natural solution to the problem. But they are not so destined. Engineering education has become the training ground both for future professional engineers and for those who wish to hold positions in the general broad field of technology surrounding the profession of engineering. This is easily demonstrated. We have by census figures only 275,000 persons in the United States who classify themselves as engineers. Probably no more than 100,000 of these persons could qualify under the most liberal definition of professional engineers engaged in active practice. By now it requires no oracle to predict that fully 125,000 young men will be enrolled in our engineering colleges when enrollments become stabilized. Clearly it is wrong to assume that 125,000 trainees are needed as replacements for 100,000 or even 150,000 professional engineers.

As these young graduates are absorbed by industry, at least one half will be drawn into positions on the fringes of the profession such as sales, promotion, operation, and later management. For these, a longer period of study than four years seems unreasonable and they would, no doubt, give up engineering study if curricula became too highly professionalized. This might not be an adequate reason for curtailing the development of professional engineering education, but with our graduate schools supplementing four-year programs, no obstacle exists to such development.

Horizontal Options. Evidently the greatest success of our present curricula has been in educating the great body of practical professional engineers, *i.e.*, planners, designers, and producers. There has been little opportunity for special training of research men or managers. The several regular curricula then form the first major horizontal option, an option to be selected by those of broad interests or of normal abilities who are not especially qualified for the more scientific phases of engineering development on the one hand nor obviously destined for the

non-technical or management operations on the other. No doubt a majority of all students will profit most from these traditional engineering studies.

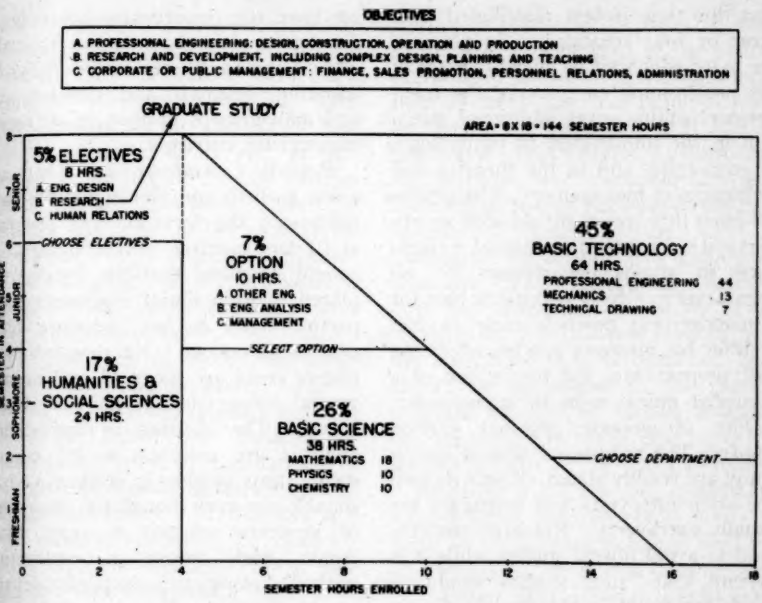
Research and Development Options. Every teacher of engineering has had the experience of observing those students who, finding real pleasure in mathematical derivations, might go much further with these studies than is possible in the usual undergraduate classes. Although these students do well in all departments they often drift back after graduation confused by the lack of opportunity to use this talent. Such students should have an opportunity to work in research and development, and they can be trained for this opportunity.

The essence of this training as it is being established at Illinois Institute of Technology consists of meeting two objectives. First, we wish to teach the student how to apply mathematics to the analysis of engineering problems and second, we wish to provide him with an opportunity to work with an eminent research engineer as an apprentice for learning the techniques of research.

It is important to realize that the capacities of our students for solving mathematical equations far outstrip their limited abilities in expressing physical conditions as equations that can be solved. Accordingly, five integrated courses in applied mathematics and engineering analysis (15 credit hours) have been established which students in the research and development option of each department will take in common. Two of these courses are primarily a study of mathematical techniques which will be used in the other three courses in engineering analysis. These three courses in analysis are in the fields of electricity, heat and mechanics, but unlike the usu undergraduate courses, they wi strongly emphasize the basic math matical approach.

Operation of Research Options. Th key we believe to the successful opera tion of these five courses is their inte gration through an administrative com mittee composed of those who wi teach the courses themselves. It i planned that the teachers will meet to gether bi-weekly with the objective o making the mathematics taught by th mathematician useful in their course and of keeping each of the engineering teachers fully aware of the procedure and problems used by his associates Eventually we hope thus to develop corps of teachers for the courses i engineering analysis and even in mathe matics who can enrich their course by showing how a given set of equa tions may express physical phenomen of several engineering fields. Such teachers are rare indeed today.

The other objective of giving th student an apprenticeship in researc techniques is more easily achieved Each student accepted for option study in research and development wi be freed from four to eight credi hours of senior course work in engi neering and will be assigned to a re search professor. This professor wi accept the student as a research ap prentice but will likewise accept th responsibility for providing a thorou educational experience for the stude which is not available to the usual as sistant. The research experience ma be either experimental or theoretica but regular reports will be require (not a thesis). Students who gra through this experience will no doub be encouraged to enter a gradua school. The research and developme option takes up the time of one fu



semester and leaves seven semesters of work in parallel with the regular engineering curriculum of the department.

Management Options. It is believed that research and development students will select themselves by giving evidence of special scientific interests and abilities by the end of the sophomore year. It may be more difficult to choose those who should study in the management options although the criteria seem reasonably clear. We might expect management students to be found among those who had not distinguished themselves in mathematics and physics even though their entrance examinations showed a high level of intelligence. We would expect many of them to appear among the leaders in campus activities. We would hope to find them doing well in such studies as English, history and economics.

It seems likely that by the end of the sophomore year these future administrators will have become sufficiently aware of the directions of their expanding interests to ask for advice about option study if it is available. We must remember, however, that both limited options, *i.e.*, research and development, and management, are intended for the education of leaders and that a youngster who has no very obvious reason for selecting one of the limited options should clearly be advised to take the regular professional curriculum. If the research and development option becomes a haven for introverted egocentrics while the management option becomes a catch-all for scholastic incompetents, each will fail to serve a useful purpose.

A full semester of eighteen credit hours is needed to set up a proper management option, and it seems clear

that this time is best distributed over three or four semesters. In place of the more advanced technical courses of the professional curriculum, the management option gives additional attention to the humanities, to psychology, to economics, and to the theories and techniques of management. The graduate from this option should seek an opportunity for broad industrial experience in many departments of an organization, which will mark him for a management position early in life. Neither his interests nor his education will prepare him for the career of a specialist unless it be in management.

The Arguments Against Option Study. The arguments against option study are readily stated. Research men are often introverts and managers are usually extroverts. Research students tend to avoid liberal studies while it is evident that "such studies would be good for them." Management students must be excused from the more technical subjects but "unless they get such information in school they will never get it." Although both criticisms are just, they fail to consider the impossibility of completing any education in college and they fail to recognize that although we can try to teach anything to anyone, the student will learn only in proportion to his interest in and aptitude for the subject matter. The rules of good writing are far less complex than the rules of football; they would be learned as quickly if the interest of the student could be maintained at the same level. Since we have only a limited amount of a student's time, we can expect a far greater accomplishment if his program is fitted as closely as possible to his interests and aptitudes. Instead of multiplying the number of vertical subdivisions or branches of the curriculum, we have the opportunity not only t develop student interest but to mak use of his aptitudes more fully b adopting research and developmen and management options in all maj engineering curricula.

Realistic Considerations. There ar a few realistic considerations that hav influenced the form of this progra at Illinois Institute of Technology. I should be noted that the options ar placed in each major engineering de partment and do not, therefore, for new departments. No new adminis trative costs are incurred and depart mental cooperation in the plan is as sured. The courses in engineerin analysis are common to all depart ments, thus producing sections of rea sonable size even though the percentag of students selected is very smal Again, each course in engineerin analysis belongs to a particular depart ment; the plan does not siphon o scientific students to enhance the pre tige of other teachers. Managemen options are set up to meet the minimu requirements of each department fo awarding its designated degree. Hen both the student and the departmen obtain that satisfaction associat with the pride of individuality.

Division of Engineering Curriculum into Blocks of Courses

Explanation of Chart. The writ devised the chart attached to illustra the division of the engineering curr ulum. This is a simple area cha with ordinates in semesters and a scissas in semester hours enrolle Hence, the total area is equivalent the total semester hours (144) in engineering curriculum. If one sta at the bottom of the chart with the troductory freshman semester a

works upward, it is possible to picture the subdivision of the curriculum between the major blocks of courses in a rough way semester by semester. The blocks themselves are designated both in total semester hours and in percentages. Thus Basic Science (mathematics, physics, chemistry) covers 38 semester hours or 26 per cent of the curriculum. This block is completed by the end of the sophomore year, as is made clear by its location in the lower half of the chart.

The block labeled Basic Technology covering 64 semester hours, and, increasing in intensity from the freshman to the senior year, includes the minimum engineering requirements of the department granting the designated engineering degree. Humanities and social sciences represent the other required block of courses. These subjects are shown extending over three years although in actual curriculum building it was found possible to extend some of this work into the senior year.

At the end of the sophmore year, the chart shows that the student is expected to choose an option marked A, B or C. Then in the senior year certain electives occur in each curriculum which provide an opportunity for the student to expand his interests in the direction of his optional study. Option work is entirely designated; electives are selected under guidance by an adviser. There are no so-called "free electives" of consequence. In total, therefore, the optional study amounts to the sum of the areas on the chart marked Option and Electives or 48 credit hours which is equivalent to 32 per cent of the curriculum. This is approximately the equivalent of one semester of study.

Humanistic-Social Studies. After long study a committee of the faculty found itself unable to agree upon more than 24 credit hours of required work in the humanistic-social field for all engineers. This amount, as illustrated on the chart, was somewhat less than the total of twenty per cent of the curriculum advocated by the S.P.E.E. Committee on Engineering Education after the War.* Incidentally, that report had stimulated the study of all curricula at the Institute and, in fact, the system of options described here should be considered as the specific program adopted by Illinois Institute of Technology to carry out the broad objectives put forth by that Committee.

Although it did not seem feasible to require more than 24 credit hours of work in the humanistic-social field for all engineers, the option arrangement as adopted does provide much more than the recommended twenty per cent for some students. Those selecting the management option will elect a minimum of eight additional credit hours of humanistic-social courses to form a background for their future work in human relations. As a strengthening of the humanistic-social studies for all engineers, each engineering curriculum in the junior and senior years contains nine credit hours of liberal-studies elective (three, 3-hour courses) which places a part of the important work in the upper years of all curricula. Moreover, these are not free electives. They must be chosen for their relationship to an approved objective or interest.

*Report of Committee on Engineering Education after the War. S.P.E.E. JOURNAL OF ENGINEERING EDUCATION, Vol. 34, No. 9, May 1944.

Physics Column

Attention of members of the Physics Division is called to a series of papers appearing in recent issues of *The Ohio State Engineering Experiment Station News*. The series is introduced by Alpheus W. Smith, Dean of the Graduate School and Chairman of the Department of Physics, in a paper entitled "Engineering Physics—A New Profession." The theme is made apparent from the following quotation: "The fruitfulness of bringing the latest results of physics into industrial research laboratories is now generally recognized. For this reason engineering physics is becoming a profession in the same sense that engineering and chemistry are professions."

Dr. Smith proceeds to introduce papers from a number of his former students now holding responsible positions in industry. The papers have been selected to give some indication of the scope of activities which Dr. Smith regards as engineering physics. Many of the writers are graduates in the Ohio State University curriculum in Engineering Physics. Some hold advanced degrees and some do not. The papers appear in *Engineering Experiment Station News*, Vol. XVII, Nos. 3 and 5, June and December, 1945.

The following announcements of openings for Graduate Assistants have been received:

The University of Oklahoma offers assistantships and research fellowships at stipends ranging up to $750 for the academic year for holders of the degree of B.S. and up to $1,000 for holders of the Master's degree. Applicants should communicate with William Schriever, chairman, Department of Physics, University of Oklahoma, Norman, Oklahoma.

Purdue University offers teaching assistantships starting at $100.00 per month. Applicants should communicate with K. Lark-Horovitz, Head, Department of Physics, Purdue University.

The Agricultural and Mechanical College of Texas offers graduate assistantships commencing at $700 for the academic year for holders of the B.S. degree and at higher stipends for holders of the master's degree. Applicants should communicate with J. G. Potter, Department of Physics, A. & M. College of Texas, College Station, Texas.

A program of four sessions is being arranged for the joint meeting with the A.A.P.T. in St. Louis: one session with the Division of Engineering Mechanics, a second session on Physics Courses and Texts for Undergraduates beyond the Sophomore Level, a third session on Engineering Physics, Physics for Technical Institutes and related subjects, and a fourth session for Contributed Papers. The complete program will be distributed by the A.A.P.T. to its membership in May.

JAMES G. POTTER,
Chairman